SILICON CHIP

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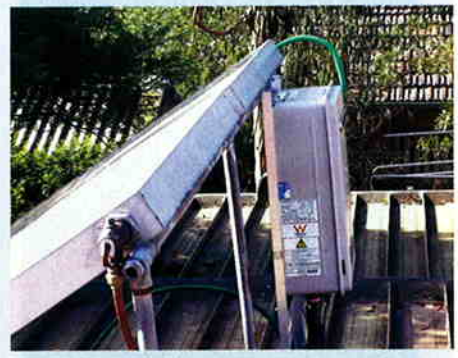

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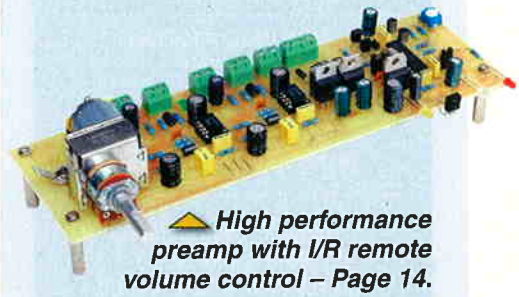

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Publisher's Letter

Technology is fighting the war against terrorists

No one can fail to be alarmed at the recent terrorism attempts against Glasgow Airport and a number of London night spots. It was only by very good fortune that the car bombs failed to explode and the attack at Glasgow was stopped at the last moment. Even more alarming are the reports that some of the people involved are foreign doctors who have attempted to gain entry to Australia to work in our hospitals.

Some people have implied that the terrorists were inept because the bombs did not work. It would have been a different story if they had exploded, as they could normally have been expected to. Then the terrorists would have been regarded as successful, of course. After all, the car bombs used the same methodology as has been used with monotonous regularity in Iraq and other parts of the world. So people in the UK have been truly fortunate.

The good fortune was extended because the unexploded car bombs revealed a great deal of forensic information, especially from the mobile phones which were to be used as the triggers. It turns out that the phones were rung several times by the bombers, to trigger the explosions. All of this information and a great deal more has been gleaned from the phones, including some of the links to Australia.

Even if the bombs had gone off, it is likely that the authorities would have been able to retrieve the SIM cards in the mobile phones and their investigation would have progressed rapidly from that point, as phone call and SMS message records on them were all linked up. And even without the phones, the authorities would have been able to make quite a few connections back to the bombers via the vast number of CCTV cameras which are used throughout London. Not only would these cameras have been used to reconstruct the bombers' car journeys to their final destinations but many of these cameras would also have number plate recognition to make the job easier.

Even so, it would presumably have been a monumental task even with the assistance of sophisticated computer technology. No doubt face recognition technology would also have been used as well, so ultimately, the terrible web woven by these evil people would have been unravelled.

In case you are wondering, while not in the same quantities as in London and other major cities worldwide, there are now considerable numbers of CCTV cameras employed around major Australian cities. You would hope that, with the strong connections that Australian anti-terrorist authorities have back to the UK, they could be used to detect or unravel a terrorist attack here as well. It seems likely that an attempt could be made at some time in this country. Let us all hope that no attempts are made.

Lest anyone rest easy that the authorities are on top of terrorists, nothing can be further from the truth. Would-be terrorists can be expected to learn from past mistakes and they are likely to take more precautions against any detective efforts after their attempts. If you want evidence of that, one only has to see how people robbing auto teller machines have adopted masks and other measures to prevent identification from the inevitable camera surveillance. Terrorists will do the same.

As one who finds the increasing camera surveillance throughout our cities and on the roads disquieting and a challenge to individual liberties and privacy, I have to admit that this "big brother" technology can have a good side if it prevents the carnage that occurs when terrorist attacks are successful.

Leo Simpson

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Microphone mute circuit is crude

I have some reservations on the microphone mute circuit published in the Circuit Notebook pages of the April 2007 issue. First, there is no provision for powering the FET in either version. Phantom power provides 48V, with positive on both pins 2 and 3, negative on pin 1. The battery-powered version does not connect the battery negative to the circuit.

Second, it is very poor audio design to short out a signal path, especially a low level one such as a microphone or to impose anything prior to the preamp. Normal muting is done by interrupting the signal by either a hardware switch on the microphone body or in the mixer, or more usually by a VCA such as a noise gate.

I used several methods of control of leakage on front of stage mikes as far back as 1972, when I designed the Grateful Dead's Wall of Sound system. We used two instrument-grade differential mikes which cancelled in a preamp and inverse summing circuit at the mike mounting. Later, a VCA circuit was built with an industrial-grade switch pad (such as is used to control heavy machinery) and connected via an insert jack on the mixer.

The switch pad must be sourced from an industrial machinery dealer; I had to go to the US for mine. All of the commonly available switch pads are lightly constructed of flimsy foil, easily damaged and very unreliable. This is very important to allow a quick bypass in case of failure of the pad or circuit.

Today, in my PA I use the same industrial-grade switch pad with a simple signal generator to feed an 800Hz tone into the key insert on a Drawmer 201 noise gate. The use of a noise gate allows a precise adjustment of the attack, delay and amount of signal reduction during gating; a total mute is neither necessary nor desirable.

Bear Stanley,
Atherton, Qld.

Flashing CFLs may be due to leaky switches

I read with interest the letter (Mailbag, page 4, May 2007) about flashing CFLs when the power is apparently off. I live in a house built in the 1960s and I too had the same problem with fluoro lamps flashing spuriously.

I put the problem down to leaky switches. They were the old PDL ones and were full of dust and they don't actually provide good isolation, especially when 30 years old.

I had on previous occasions tested the circuit while the switch was turned off and NO LAMP fitted. A digital multimeter confirmed that 230VAC was still present, however there was not enough current to light an incandescent lamp. I changed the light switch for a new one (also by PDL) and the problem (same symptoms you describe), with the CFL flashing spuriously, went away.

I have to say that leaky switches are common and a wall switch shouldn't be relied on as a means of isolation. I think you will find most electrical people are warned about this in their training. Removing the fuse (or wire to breaker) is the only sure means of isolation.

I do wonder how much energy is being wasted by leaking switches, on a national or an annual basis.

Alex Scott,
New Plymouth, NZ.

Conventional current flow is logical

I am compelled to comment on the letter "Electron Flow Versus Conventional Current Flow" (Silicon Chip, July 2007).

In simple terms, if one considers electron flow, then upon connection of an external circuit to a DC voltage source, the positive terminal of the source can be said to attract an electron which, once moved, leaves a positively-charged "hole" in its place. Another electron in the string will move into this "hole" and, in turn, leave a hole in its place, and so on.

As this process continues, all electrons move from the source's negative terminal to the positive terminal.

However, if you think about the direction of the "hole" movement in the above process, it is effectively moving in the opposite direction; ie, from the positive terminal to the negative terminal. Thus, current flow can be thought of as the movement of electrons from negative to positive OR as positive charges moving from positive to negative.

Personally, I am happy with the conventional current flow method as used in Silicon Chip magazine.

Terry Ives,
Penguin, Tas.

CFLs will add to land fill

With regard to the CFL debate, I agree that CFL development is still in its infancy and there are too many situations where they are not suitable. More progress is needed before they can ban the incandescent.

I actually have two of these "free ones" plus one I purchased installed in three rooms where they are usually left on for a while and they are OK. The one I purchased, a Philips 18W "daylight", is excellent with no turn-on flicker. The two freebies have turn-on flicker and an awful "warm

Car speedos are meant to read high

Regarding the recent letters expressing concern about inaccurate speedos, the writers and the Editor are quite right about them being inaccurate but this is deliberate.

As a scientific instrument maker years ago, I used to repair and calibrate civilian and police speedos. Police speedos were the only ones calibrated to read precisely (to allow them to accurately monitor road users' compliance). Every other speedo was calibrated to read about 4km high at 60kmh (or about 6% high).

However, all odometers are calibrated to read accurately. Traditional odometers are gear driven (not readily adjustable), while speedos are magnetically coupled (to allow adjustment). Modern electronic odometers are similarly hard to adjust.

The reasons for this are that it is impossible to maintain an exact road speed as indicated by your car's speedo. Imagine trying to stay on exactly 60km/h or 100km/h; the only way to stay within the limit and avoid a fine would be to keep your speed below the limit indicated on your speedo. A leeway of a couple or so km/h allows the driver to keep the needle near the required speed, without suffering nervous tension trying to monitor and adjust their speed.

I am concerned that some may be tempted to calibrate their speedos precisely and therefore risk driving at unsafe speeds or being prosecuted for it.

Adrian Leake,
Tamworth, NSW.

Comment: you make some interesting points. In fact, even higher errors are called for under the Australian Design Rules.

As we interpret the ADR spec, the indicated speed can be +10% of the true speed + 4km/h. This could result in a car speedo indicating 114km/h when the true speed is 100km/h.

This could lead to real problems if the driver knows that the speedo is wildly optimistic and then drives accordingly. In doing so, the driver would still be driving legally (ie, not exceeding the speed limits) but would be in all sorts of bother if he (or she) had an accident and then a passenger in the car told police the indicated speed at the time!

We would agree with your point about the difficulty of sitting on an exact speed were it not for the fact that many cars now have cruise control which makes precise speed maintenance a doddle – except when going down hills.

We think you may also find that large trucks which have 100km/h speed limiting are set quite accurately and this leads them quite naturally to "tail-gate" motorists who are sitting at 94km/h (or whatever) in the mistaken belief that they are driving at the legal limit. The truck drivers are right to want to sit at their maximum speed, as they quite naturally want to get to their destination as quickly as possible, so it must be very frustrating for them as well.

Also it does seem quite ludicrous for modern cars to have digital speedos with such large errors. We think it may be time for the ADR speedo regulations to be updated.

daylight" colour. I opened up a broken one I had and as usual, when these things are discarded, they will become useless electronic junk to be added to landfill.

In my opinion, the choice should remain with the consumer whether to buy incandescents or CFLs. Tell the government to concentrate on the big power users such as air-conditioners, electric cooking and electric hot water; these use lots more power than domestic lighting.

Salvatore Sidoti,
Strathfield South, NSW.

High-resolution audio frequency counter

In the April 2007 issue, there was a request for a high-resolution audio frequency meter. The Fischer and Porter single loop controller of about

Atmel's AVR, from JED in Australia

JED has designed a range of single board computers and modules as a way of using the AVR without SMT board design

The AVR570 module (above) is a way of using an ATmega128 CPU on a user base board without having to lay out the intricate, surface-mounted surrounds of the CPU, and then having to manufacture your board on an SMT robot line. Instead you simply layout a square for four 0.1" spaced socket strips and plug in our pre-tested module. The module has the crystal, resetter, AVR-ISP programming header (and an optional JTAG ICE pad), as well as programming signal switching. For a little extra, we load a DS1305 RTC, crystal and Li battery underneath, which uses SPI and port G.
See JED's www site for a datasheet.

AVR573 Single Board Computer

This board uses the AVR570 module and adds 20 An./Dig. inputs, 12 FET outputs, LCD/Kbd, 2xRS232, 1xRS485, 1-Wire, power reg. etc. See www.jedmicro.com.au/avr.htm

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Mailbag: continued

Technology has ignored the deaf

Technology appears to have sadly ignored the deaf over recent years. Rapid advances in software and miniaturisation have produced the current powerful crop of mobile phones, yet still the deaf are depending on amplification as the only "cure", albeit with sophisticated spectrum adjustment.

Next time you are down the pub with your mates, try stuffing a very thick sock in each ear and see how isolated you become. People will look at you as though you were stupid the third time you ask them to repeat something (not just because of the socks), then soon ignore you completely.

How hard can it be for the bright boys to come up with the concept of building a speech recognition module into a mobile phone, for example? We already have a vibration ring tone, a microphone and a text display and a multitude of frivolous side effects (camera, email, etc).

Better still, how about a portable hand-held device that docks with a phone line base but can be switched to local mode, allowing it to be carried at all times to assist in many difficult situations?

Brian Critchley,
Elanora Heights, NSW.

20 years ago did this, as at the time many process control devices had a frequency output which was more accurate than the alternative 4-20mA analog input. It used a radiometric technique to calculate a high-resolution frequency measurement across a wide range of frequencies.

This technique needs a reference frequency and three controllable counters. It had an explanation of how this was done in the manual. To see what can be achieved, see the specs for the modern equivalent: **http://www.micmod.com/Docs/Specs/MicroDCI/S-DCI-53SL6000_2.pdf**

Graham Shepherd,
New Town, Tas.

Don't throw out those dead CFLs

I would like to make a comment on the proposed incandescent lamp ban, as discussed in the April 2007 issue of SILICON CHIP. In the States we are just starting to use CFLs to replace incandescent bulbs. They are slow in catching on because it is voluntary, not mandatory. I believe they will never replace incandescent bulbs completely. There will always be a niche for them.

I would like to suggest that people save burned out CFLs. You can salvage parts from them. They have a transformer, inductors, capacitors (some high-voltage types) diodes, resistors and maybe transistors or Mosfets which can be used again.

Craig Kendrick Sellen,
Carbondale,
Pennsylvania, USA.

Congratulations on the Class-A Amplifier

I would like to congratulate you on the 20W Class-A Amplifier being featured in May 2007 and subsequent editions. You can be sure it will be a welcome addition to many a constructor's corner. And many boffins who have previously requested a valve amplifier would be happy with this but is it a solution for those still yearning for a good classic valve amplifier? In my opinion, No!

Just recently, we would have been content to purchase an offering from the spate of Chinese valve amplifier imports but there appears to be a little greed governing the prices, as they have skyrocketed, putting the cost outside the mainstream purchasers' budget. So sadly, we once again have to prostrate ourselves and beg for a stereo valve amplifier, maybe using Chinese output transformers if the quality and reliability is there.

Greg Johnson,
via email.

Digital amplifiers sound very good

I was rather amazed to read in the letters section in the July 2007 issue (page 3) this month that SILICON CHIP doesn't seem to think digital amplifiers sound very good.

You must be listening to some very poor examples because I currently

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LP to CD conversion software

I've been reading your recent articles regarding LP to CD conversion with enormous interest. My core business involves recovering, cleaning, and digitising audio recordings of all types for all kinds of listeners and despite the possible detrimental effects to my business by such a "how-to" article series, it's great to see a focus on retaining and (more importantly) preserving our audio heritage.

I know you can't cover all the software that's out there currently and I know myself how hard it is to get good software to help protect and recover audio recordings. But I was really surprised to see the absence of any mention of possibly the most powerful and flexible commercially available audio editing software, Adobe Audition, and to a lesser extent, Diamond Cut (which I believe is an Australian software development)!

I've been using Audition since the early 1990s (when it was called Cool Edit Pro) and I've tried every software package mentioned in Barrie Smith's article (and many more besides) and I've found all of them to be surprisingly inferior in terms of flexibility, speed, and ease of use. I'm sure everyone has their favourite editor or filter software but I can assure you Audition allows me to do things that the rest of the other software mentioned in the article can only approximate (at best).

Try getting ANY of the software packages mentioned to load and edit an 8+ gigabyte 192k, 24-bit PCM file in less than four minutes - and by edit, I mean edit down to the individual sample if required! The best of the packages mentioned has difficulty opening (let alone editing) a 4-minute 44.1k/16-bit PCM file! I do appreciate that not everyone needs this kind of power or flexibility but it is commercially available and it's easier to use than just about any of the packages mentioned.

The results we've had with Audition are so good (for all types of audio recordings and audio problems) that we're even started getting work sent to us by the Australian Film and Television Archives! Unfortunately, Audition comes at a fairly high price ($A1600) but this software has built and is continuing to improve our audio recovery and repair services every day!

Peter Naus, Audiography, Mitcham, Vic.

have in my system a digital amplifier which cost me only $70 and which because of the quality of its sound has completely stalled any plans I have or had to build either a class-A or class-AB amplifier such as those published in your magazine.

As much as I enjoy reading your audio articles and building your designs, I simply can't justify the expense of building amplifiers when digital amplifiers such as the Sonic Impact can give me such good sound for so little outlay. In Australia right now you could easily get at least three models of digital amplifier, all under $300, that would easily sound as good as any commercial solid-state amplifier costing up to $1000 or more!

Of course, they are not powerhouses by any means but as long as one keeps that in mind and uses them wisely then you are rewarded with excellent sound quality for very little outlay.

I have mine partnered with the SILICON CHIP valve preamp and the sound is thoroughly enjoyable. And of course, they are efficient and so use very little power (a point which was overlooked in the same issue that discussed energy conservation!). It is for this reason that I wish you would focus more on line stages, headphone amplifiers, valve buffers, etc because the need to construct power amplifiers is for me at least gone.

Rob Knutsen, Doncaster, Vic.

Comment: You have got to be kidding – it is highly unlikely that a $70 digital amplifier will sound anything but ordinary. In fact, we recently tested a 15W/channel digital amplifier with pretensions to high fidelity. It was flat

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out producing 7W into a single channel and its distortion was awful. Mind you, it was cheap!

Kurrajong Radio Museum acclaimed

My congratulations for the excellent Vintage Radio article by Rodney Champness in the May 2007 issue on the Kurrajong Radio Museum. The information is very well reported and the extensive, detailed photos are very informative.

Hats off to the museum curator, Ian O'Toole for making such a grand effort to establish the museum and for taking such great care in the preservation of the historical radio items in his custody.

Graeme Dennes,
Bunyip, Vic.

PIR detectors have six terminals

I was reading "Ask SILICON CHIP" in the April 2007 issue and I came across the question concerning PIR detectors. Your answer is inaccurate. Most, if not all, detectors have six terminals. Two are for the supply rail to the detector; usually 12V DC but occasionally 24V DC and even 24V AC. Two are for the anti-tamper loop; these are connected to the sub-miniature microswitch and monitor the detector's case. The case normally holds the microswitch closed, which in turn holds the tamper terminals closed.

The remaining two terminals are for the alarm circuit and are connected to a relay which is controlled by the PIR circuitry. When power is connected and the detector *has not* detected movement, these terminals are closed circuit. If power is removed or fails, or if the detector detects movement, these terminals are open circuited.

The alarm terminals do not sink or source current in any way (unless it is a specifically designed detector). They only go open or closed circuit through a relay.

Most, if not all, alarm systems use a closed circuit loop on all detection circuits as this ensures alarm activation if the wiring is cut. The use of an "end of line" resistor is also extremely common as this allows the alarm panel to detect shorts in loops, as when someone tries to bypass a detector by connecting a short across the loop wiring. The panel "sees" the higher voltage across its alarm terminals (because the end-of-line resistor is no longer in circuit) and this triggers an alarm. Very few "open loop" detectors are used nowadays as they are too easily defeated.

Most modern panels will also use end-of-line resistors of different value to allow several alarm zones to be monitored by just one set of terminals. The Bosch 880 series of alarm panels use two different resistor values to give two zones per alarm loop. These resistors are usually an odd value, eg, 3.3kΩ and 6.6kΩ 1% 5W. The 3.3kΩ resistor is one zone and the 6.6kΩ resistor is the other zone.

In this manner, an 8-zone panel can be programmed to become a 16-zone panel. The zone wiring remains the same apart from the use of the two different end-of-line resistor values.

Wiring an alarm loop to source or sink current or voltage is simple; just connect one of these terminals to either the positive supply terminal or the supply ground terminal, with the appropriate current limiting resistor. To use the average PIR detector on the PC-Controlled Burglar Alarm, I would wire one terminal to ground or negative and wire the other back to the PC-Controlled Alarm through a current limiting resistor of, say, 10kΩ. When the detector detects movement, the alarm contacts go open circuit and the PC alarm output thus goes high.

Just remember to adjust the software accordingly.

Dave Sargent,
Howard, Qld.

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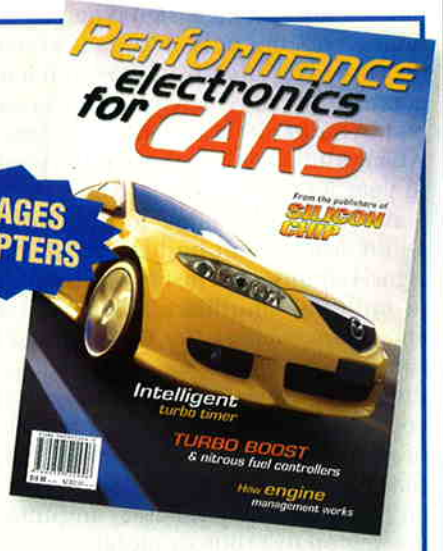

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How To Cut Your Greenhouse Emissions

More environmental surprises – how solar water heating can be worse than gas, about fake "green electricity" and are carbon offset schemes the answer?

In last month's article, I said that solar water heating was an excellent idea. I lied! Well, maybe not completely but I have to tell you a longer story.

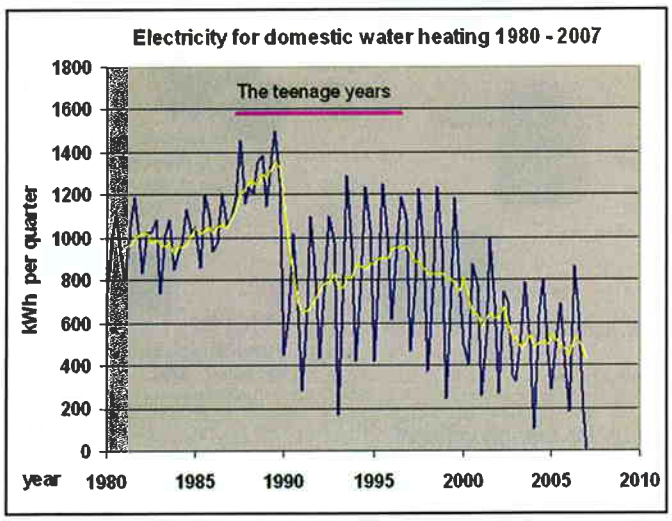
Seventeen years ago I connected solar water heating panels to our electrically heated off-peak hot water service. It's still working – that's the good news. The not-so-good news? Before the installation we used 4300kWh per annum for water heating, since then 2800kWh. This is a reduction of 35%. Why is it so modest?

Competition!

The big problem is that the solar and the electric booster compete with each other. If it is a cloudy day, then overnight, electricity heats the water. If the following day is sunny, the solar has not much to do.

The temptation of course is to turn off the electric heater altogether and go 100% solar. This often works quite well for a while a time in the summer months. Then the inevitable happens – you run out – and you are the bad guy – the greenie!

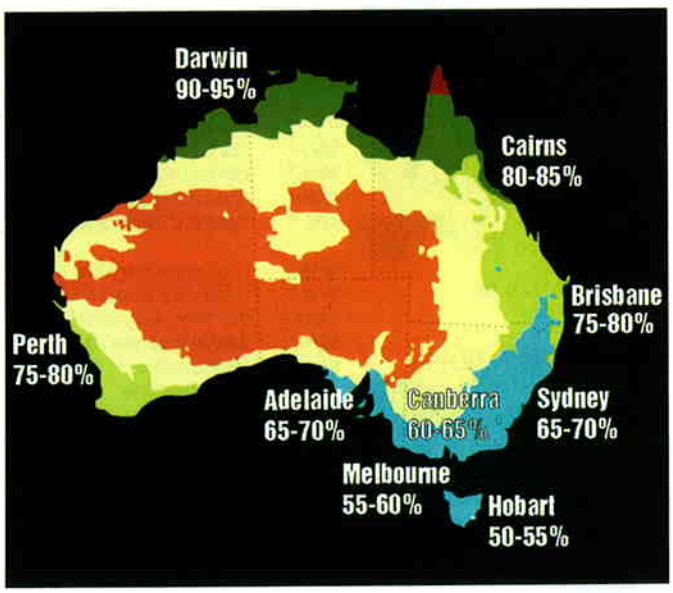
Here is a graph of my home electricity use for domestic water heating. Obviously 1989 was the year we installed the solar panels. What about the years 1986 – 1996? Why was it always climbing? The answer: Teenagers! We had two boys.



By 1997 they had started to behave more responsibly. By about 2003 they had both moved out, as you can see from the graph. In fact you can almost read the history of the family through the hot water service!

Solar water heating: does it really save money?

The map below shows the proportion of solar contribution you can expect across Australia. As you can see, you need to live in Cairns, Brisbane, Perth or Darwin to get more than 75% from solar. That last bit boosted by electricity is the unfortunate part.

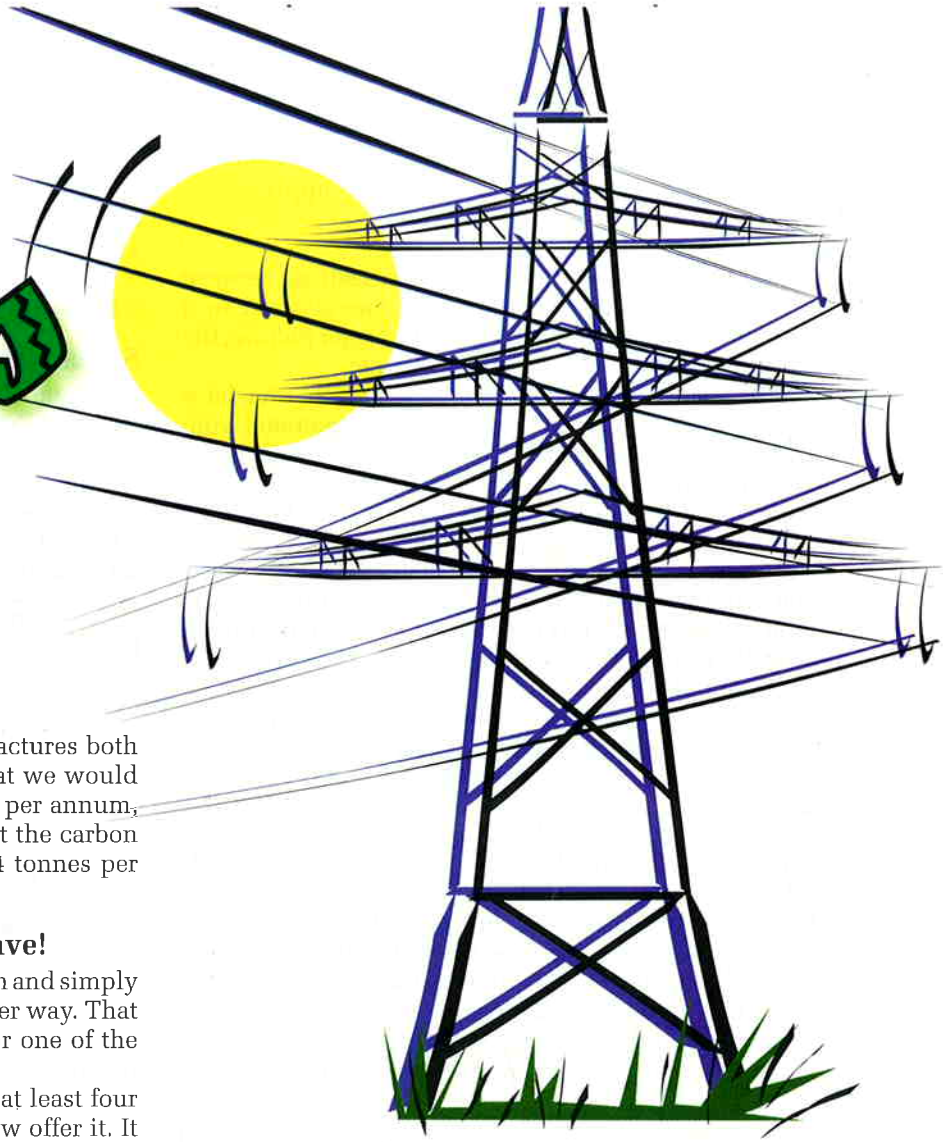


Let's consider water heating from the greenhouse gas perspective. One kWh of electricity produced by burning brown coal (as we do in Victoria) produces 1.3kg of carbon dioxide. So our solar panels were reducing our CO_2 from 5.6 to 3.7 tonnes per year. That's moderately good.

However, what if we had just opted for a normal natural gas water heater? The answer to that can be obtained from

siliconchip.com.au

Your emissions



Part II
by Peter Seligman, P hD

the Rheem hot water manual. Rheem manufactures both electric and gas heaters and the answer is that we would have used 62MJ/day, equivalent to 6300kWh per annum, more than with the pre-solar electric tank but the carbon dioxide emissions would have been only 1.4 tonnes per annum – less than half of the solar system.

Preheat your water with solar and save!

I was not planning to take out my solar system and simply replace it with a gas one. There is a much better way. That is, to use the existing solar as a pre-heater for one of the new generation instantaneous type systems.

This is no greenie "Heath Robinson" idea, at least four major manufacturers of hot water systems now offer it. It offers the best of both worlds – a solar system that can do its best without interference from a booster and a gas heater to do the rest. Even better, the instantaneous system does not have heat losses associated with having a flue.

I was horrified to discover that a conventional gas storage heater uses 25MJ/day just keeping the water hot without any being used.

To supply 150 litres per day it uses 62MJ/day. When the unit is sitting there doing nothing while you are away on holidays, three equivalent 100W light globes of heat are going up the flue, all day every day. It's a pretty good reason for turning it off when you go away!

The electric storage tank, having no flue, has much lower losses, one 100W light globe, on 24 hours a day. That's equivalent to four Melbourne-Sydney trips a year! The gas instantaneous boosted solar system wins handsomely over the others.

To summarise:

Type of water heater	kWh per year	Tonnes of CO_2 per year
Off-peak electric	4300	5.6
Solar with off-peak electric	2800	3.7
Gas storage heater	6300	1.4
Solar with instantaneous gas boost	3000	0.7

Don't even think about taking out gas to put in solar!

You might ask: why didn't I do this years ago? Water heating by using electricity is obviously a silly idea – I must have known that. Well I did. But there were several other thoughts. One was that using gas is using a limited resource, whereas there is so much coal that we will never be able to use it all.

The other thought was that coal fired power stations cannot be rapidly turned off and on. That's why the power companies sell off-peak electricity very cheaply. The thought that I had was that the coal burnt overnight will be burnt anyway, whether we use the electricity or not. That's why they were selling it for a third of the normal price. This was my thinking.

So ideally, if you remove yourself from the off-peak load, it would be good to remove yourself from the peak load too. We'll get on to that shortly.

Heat pumps?

I have mentioned the advantage of gas to boost solar but I realise that not everyone has this option. A good alternative, although expensive, is the heat-pump water heater. Examples can be checked on **www.enviro-friendly.com/quantum-heat-pump-water-heater.shtml** and **www.rheem.com.au/domestic product.asp?model=551310**

Heat pumps work by pumping heat from the surroundings into the water, in the same way as a reverse-cycle air-

conditioner can pump heat into the house. Heat pumps can provide about three times as much heating as a resistive heating element. The advantages are that you don't need a north facing roof, and you don't need a gas supply.

The bigger picture

So far I have concentrated on water heating, because water heating takes about half of the energy used in a household. However, now let's look at a bigger picture, the normal electricity load for lights, fridge etc.

For us, that's about 2700kWh/year, which translates into 3.5 tonnes of CO_2/year for electricity generated from coal. Before our change to low energy lamps, it was about 4000kWh/year – 5.2 tonnes. From that down to 3.5 tonnes was a big improvement but what's the next step? Eliminate the 3.5 tonnes!

That could be in done in two ways. We could either spend $18,000 on a grid-connected solar photovoltaic system or for about $150 per year, buy electricity from a renewable source. For a very obvious reason, we chose the second option.

A word of warning about "green" or "renewable" electricity: you almost certainly have been approached by an electricity company offering "100% renewable" for no extra cost.

Don't believe a word of it! If you have already signed up for this, check your electricity bill. It will tell you how much CO_2 has been emitted.

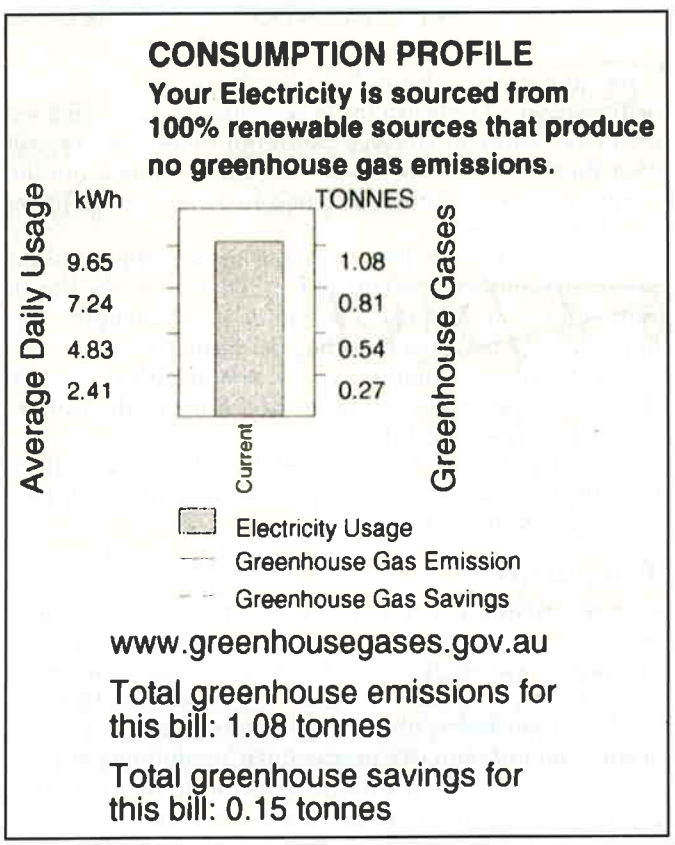
My first "100% renewable" bill, reproduced below, said "Total greenhouse emissions for this bill: 1.08 tonnes. Total greenhouse savings for this bill 0.15 tonnes".

Huh? Run all that past me again?

How one can describe that as 100% renewable source is a mystery and pure deception. In fact of the 40-odd companies/products, there are only three which really provide 100% renewable. The rest are far less.

Origin (Solar and Wind) and TRUenergy (Windpower) do. AGL do, but watch it! Unless you are being quoted about 5 cents extra over the standard rate, you can be sure you are not getting that 100%.

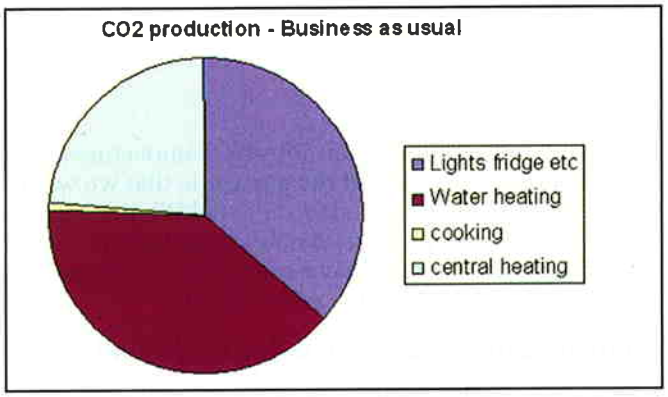
The old maxim applies – if it sounds too good to be true – it usually is. And if you do sign up – look at your bill!



Space heating

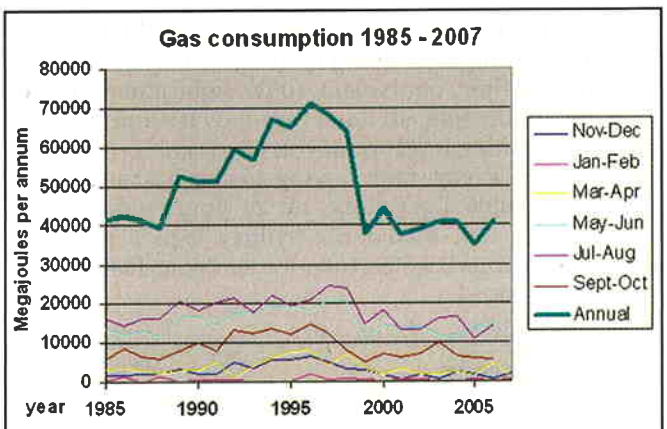
In southern Australia you need space heating, if you don't want to be the bad guy who goes around telling everybody to put on sweaters instead of heating the house.

Our house in Melbourne is heated by gas. Space heating, as you can imagine is one of the big energy users and also a big CO_2 producer. In the pre-green "business as usual" scenario for us it looked like this:

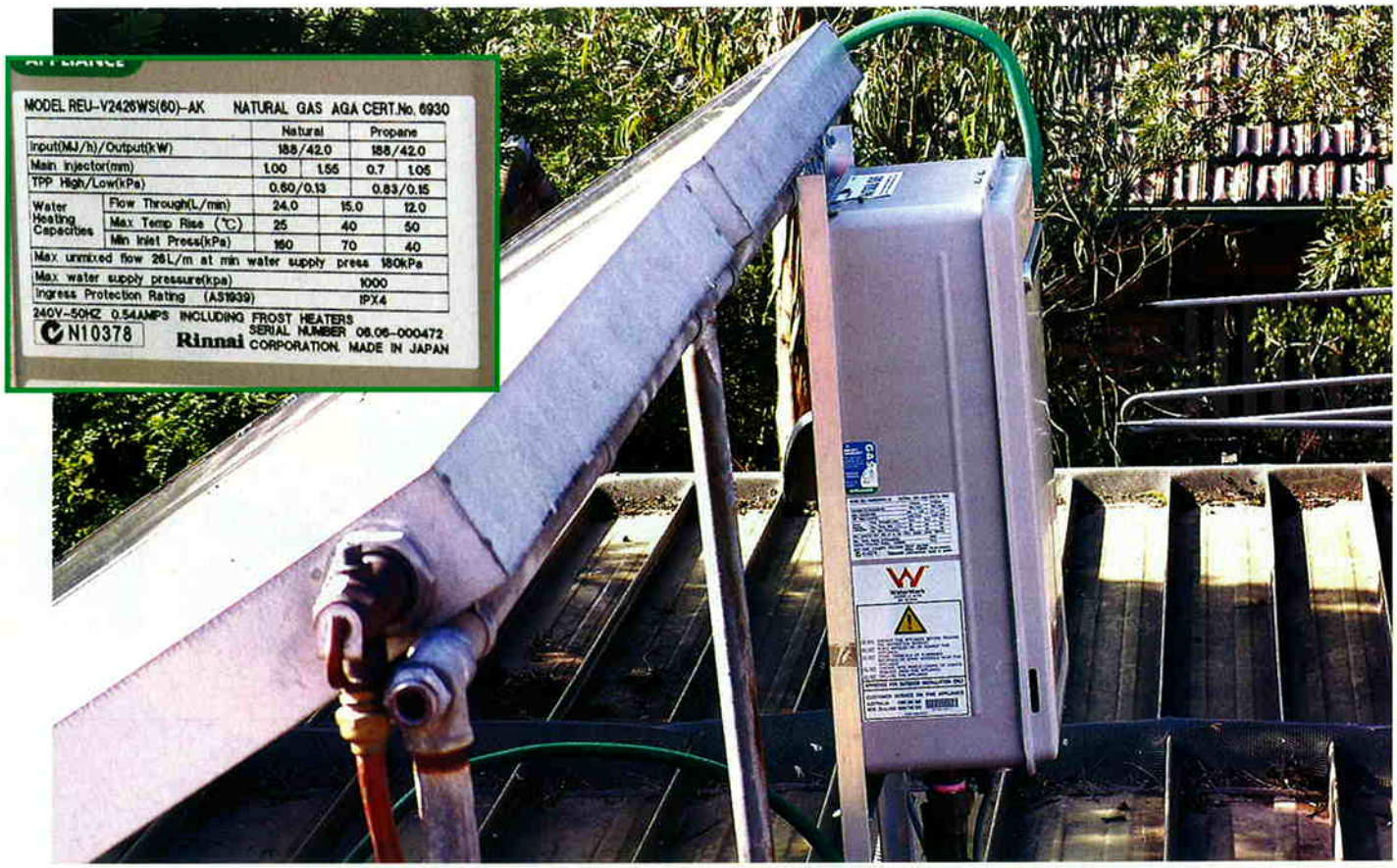


As you can see, the central heating accounted for about a quarter of the CO2 production of our house. Before we went to gas-boosted solar, our gas consumption was due to heating and cooking. Cooking, (we have a gas top only and an electric oven – as many people do) accounted for a very small proportion of our total CO2 production.

My wife cooks a lot – for a lot of people. But heating is the big gas user. We were using, on average, 55,000MJ (Megajoules) per annum. Gas is sold in MJ whereas electricity in kWh (kilowatt-hours).



This graph shows how, between 1992 and 1998, our gas consumption inexorably rose, despite numerous heating service calls. The abrupt drop was when we installed the new heating system. By the way, in 1987 we extended the house so our gas consumption is now about what it was before the extension.


MODEL REU-V2426WS(60)-AK NATURAL GAS AGA CERT.No. 6930
Natural Propane
Input(MJ/h)/Output(kW) 188/42.0 188/42.0
Main injector(mm) 1.00 1.55 0.7 1.05
TPP High/Low(kPa) 0.60/0.13 0.83/0.15
Water Heating Capacities
Flow Through(L/min) 24.0 15.0 12.0
Max Temp Rise (℃) 25 40 50
Min Inlet Press(kPa) 160 70 40
Max unmixed flow 26L/m at min water supply press 160kPa
Max water supply pressure(kpa) 1000
Ingress Protection Rating (AS1939) IPX4
240V~50HZ 0.54AMPS INCLUDING FROST HEATERS
N10378
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The author's solar hot water heater doesn't compete with the instantaneous gas heater – it assists it by pre-heating the water going into it, thus using less energy. This system has helped to reduce CO_2 emissions from more than 14 tonnes per annum down to just three. The hot water component of that three tonnes is significantly less than one tonne. Inset at top left is the gas heater's rating plate showing the output rating: 42kW – that's 420 lightglobes!

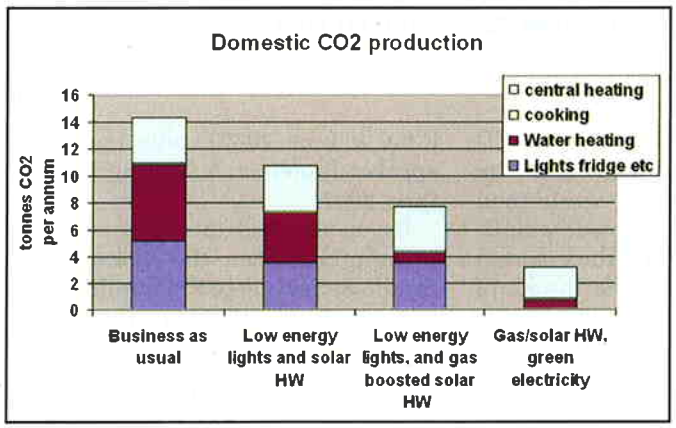
They are both units of energy. You can convert MJ to kWh by dividing by 3.6. Let's not dwell on it (see the box). To convert MJ to tonnes of CO2 produced divide MJ by 16,000.

Our central heating was producing (55,000/16,000) 3.4 tonnes of CO2 a year. It was an older type with a pilot light. I had already taken the measure of turning off the pilot light during the summer. That was using more gas than the cook-top!

I decided, rather than wait until our 10-year-old unit actually conked out, to replace it with a 5-star unit with electronic ignition. At the same time we added some insulation to the ceiling,

The combined effect (and I can't tell you how much is due to what) was that we are now using about 39,000MJ per year, a saving of 1 tonne of CO2 per year.

So looking at more comprehensive picture, on our domestic level, our CO2 reducing journey is now like this:



After taking out the silliness of electric water heating, central heating accounts for the majority of our CO2 production but at least the overall result is quite satisfying. We are producing about a quarter of the CO2 that we out started with.

You will, of course, be saying "what did all this cost?" Well it wasn't cheap but it was only a fraction of the price of a four wheel drive – and will last a lot longer!

And here's another way of looking at it: if you drive a normal-sized car instead of a large 4WD, it will decrease your CO2 production by about 2 tonnes a year (from about 6 to 4 tonnes).

For a fraction of that cost, you could potentially reduce it by 11 tonnes (from 14 to 3 tonnes per annum). SC

NEXT MONTH:

In the third and final part of this series, Peter Seligman takes a look at the economics – both in dollars and CO_2 – of electric vehicles. How do they stack up against the green lobby's bete noir, the gas-guzzling automobile? And what of carbon trading schemes? Is there a better way to generate sustainable electricity? Stay tuned: and prepare to be surprised!

Stereo Class-A Amplifier; Pt.4

By JOHN CLARKE & GREG SWAIN

Preamplifier & Remote Volume Control Module

In Pt.4 this month, we present a high-performance Stereo Preamplifier & Remote Volume Control module. It's a low-noise, low-distortion design specifically engineered for the Class-A amplifier but which can also be used with other stereo power amplifiers.

Depending on your requirements, you have several options when it comes to using the new Class-A Stereo Amplifier. Basically, the unit can be combined with a high-quality external preamplifier or used as a standalone unit.

Typically, an external preamplifier will be necessary if you want to connect several signal sources and switch between them; eg, select between a CD player, DVD player and a tuner. The Class-A Stereo Amplifier would then function simply as a power amplifier, with the signal from the external preamp fed directly to the inputs of the power amplifier modules. In this case, all you would need to build into the chassis are the left and right-channel Class-A Power Amplifier modules (May & June 2007), plus the Loudspeaker Protector & Muting Module (July 2007).

If you do elect to use an external preamplifier, then the SILICON CHIP Studio Series Stereo Preamplifier (October 2005, July 2006) makes the ideal companion unit. By the way, don't be put off by the 102dB signal-to-noise ratio quoted for that unit in the July

siliconchip.com.au

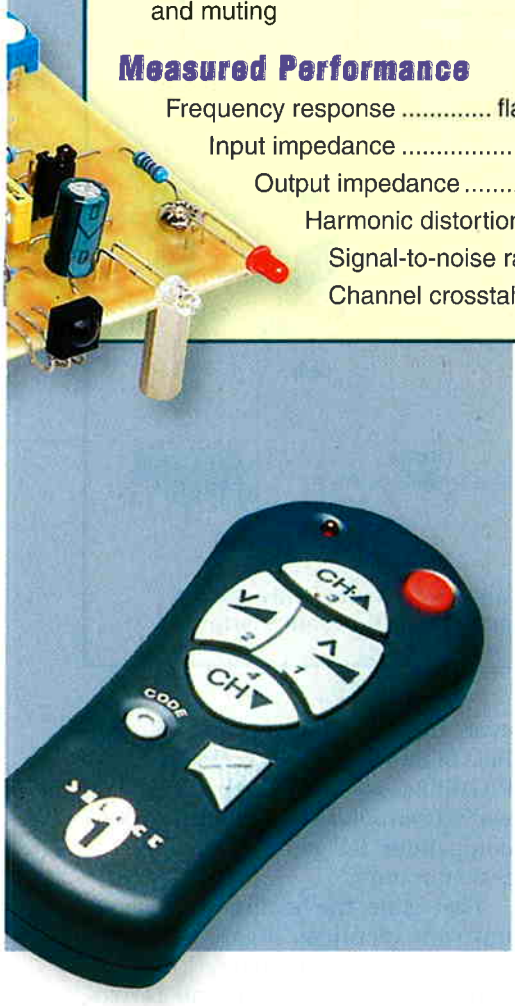
Preamplifier Features & Performance

Main Features

- High performance design – very low noise and distortion
- Designed for the Class-A Stereo Amplifier but can also be used with other power amplifier modules
- On-board remote volume control circuit with motorised potentiometer and muting

Measured Performance

Frequency response	flat from 10Hz to 20kHz, -3dB @ 100kHz
Input impedance	~22kΩ
Output impedance	100Ω
Harmonic distortion	typically <.0005%
Signal-to-noise ratio	-125dB unweighted for 1V input
Channel crosstalk	typically -125dB



2006 issue. That was a misprint – the correct figure is 110dB, so the Studio Series Stereo Preamplifier is an excellent performer that's quite up to the job (especially considering its distortion is typically less than .0005%).

Alternatively, many readers will want to use only one signal source, typically a CD or DVD player. In that case, the Class-A Stereo Amplifier can be used as a standalone unit but you do need to add a volume control. If your CD player is already fitted with an output level control, you may be tempted to dispense with a volume control on the amplifier but that could be a mistake.

Just imagine what a blast you will get from the amplifier and loudspeakers if you turn on the CD player and it has been inadvertently set to full output level. The result would not only be deafening but it could easily blow your tweeters.

The simplest solution which we would recommend is to feed the signal in via a dual-gang 10kΩ log pot and we'll show you how to do that next month, if you want to use that option. This simple scheme does have its problems though. First, the input signal level may be insufficient to drive the amplifiers to full power output, even when using a CD player. The amplifier modules have an input sensitivity of 625mV for full power but some recordings may give average output signal levels well below this.

Second, using a simple volume control varies the input impedance to the power amplifiers, thereby slightly degrading the signal-to-noise ratio. Admittedly, we're splitting hairs somewhat here but this is after all a true audiophile's amplifier.

So how do you eliminate those problems and achieve the level of performance we want? The answer is to incorporate a high-quality preamplifier module into the Class-A Stereo Amplifier chassis. This will result in an attractive self-contained package that we think will appeal to many people – particularly those who just want to use a single CD/DVD player.

The preamplifier module described here meets the above criteria. It's a minimalist design, which delivers ultra-low noise and distortion, but with more than enough gain (with the "wick" wound right up) to drive the 20W Class-A Amplifier modules to full power output. In fact, if you were to wind the wick up too far, the amplifier will be driven well into clipping and horrible distortion.

That pretty much defeats the purpose of building a high quality amplifier, so don't do it!

This preamplifier is almost identical in configuration to our Studio Series Stereo Preamplifier (October 2005). It's a 2-chip design employing a dual op amp IC in each channel, the first stage providing the gain and the second stage acting as a buffer for the volume control, to present a constant low output impedance to the power amplifier modules.

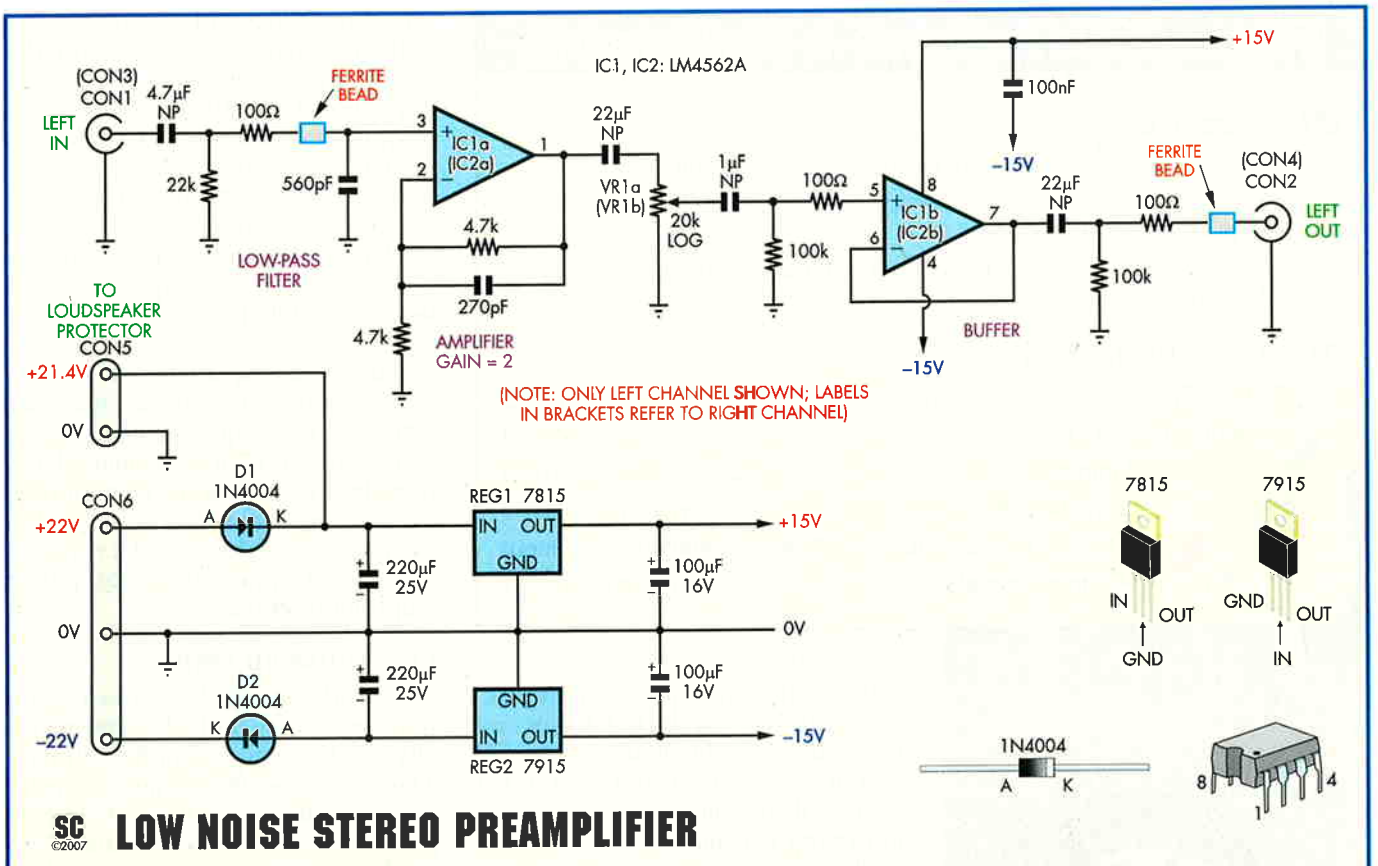
Low-noise op amps

The original Studio Series Preamplifier was based the high-performance OPA2134 op amps from Burr-Brown. These are specified at an extremely low 0.00008% harmonic distortion at 1kHz and the harmonic distortion (THD) for the completed preamplifier was typically less than 0.0005%.

This time we've gone even one better and specified the National Semiconductor LM4562 dual op amp. This new device is specified at just 0.00003% harmonic distortion at 1kHz, which is even lower than for the OPA2134. In fact, it is far below the measurement capability of any commercially available equipment, including our own Audio Precision test gear. Just how the low distortion is verified is revealed elsewhere in this issue.

As a result, the performance of the module on its own is actually far better than the completed stereo amplifier. Just running with its own regulated supplies (and not connected to the amplifier), the preamplifier module delivers harmonic that's typically less than 0.0005%, a measurement which is more or less meaningless because it is about the same as the Audio Precision equipment. Furthermore, its signal-to-noise ratio with respect to a 1V input signal is around -125dB unweighted (22Hz to 22kHz bandwidth) and separation between channels is also around -125dB.

Ultimately, it is not possible to get this fantastic performance from the completed stereo amplifier. And why not? The main reason is that residual



SC ©2007 **LOW NOISE STEREO PREAMPLIFIER**

Fig.1: each channel of the preamp is based on a low-distortion LM4562A dual op amp (left channel only shown). IC1a has a gain of two while IC1b functions as a unity gain buffer to provide a constant low-impedance output.

noise and hum from the power supply degrades the overall measured result, even though the finished amplifier is extremely quiet.

Would it be possible to get a better measured distortion performance? The answer is a qualified yes, provided we had completely separate power supplies for both channels. The same comment applies to channel separation and residual noise. Such a solution would be a lot more expensive and would probably involve two separate power amplifiers – the so-called "mono block" solution.

By the way, there's no source selection built into the preamplifier, as we're assuming that you will be using it with just a single source. If you do want to switch between different sources, then you will need to use an external switch box (or an external preamp as indicated above).

Remote volume control

OK, we just couldn't help ourselves – we just had to include remote volume control as part of the preamp design. After all, no sound system is complete these days without remote volume control and this one has all the "must-have" features.

The design is similar to an earlier unit which we published back in June 2002 and subsequently used in the Ultra-LD Stereo Amplifier. However, by using the recently-released PIC16F88-I/P chip, as opposed to the PIC16F84 used in the earlier design, we've been able to eliminate an LM393 comparator IC and the low-voltage reset circuitry.

That aside, the features of this new unit are identical. Again it uses a motorised potentiometer. Press the "Volume Up" and "Volume Down" buttons on your remote and the pot rotates clockwise and anticlockwise. It takes about nine seconds for the pot to travel from one end to the other using these controls.

For finer adjustment, the "Channel Up" and "Channel Down" buttons can be used instead. These cause the pot shaft to rotate only about 1° each time one of these buttons is pressed. Alternatively, holding one of these buttons down rotates the pot from one end to the other in about 28 seconds.

If any of the buttons is held down when the pot reaches an end stop, a friction clutch in the motor's gearbox slips so that no damage is done.

Automatic muting is another handy feature. Press the "Mute" button" on

Altronics Will Have The Complete Kit

A complete kit of parts for the 20W Class-A Stereo Amplifier will be available from Altronics towards the end of this year. This kit will come with all parts, including a pre-punched custom metal chassis and front and rear panels with screened lettering.

Altronics will also be selling the individual modules separately, for those who don't need the complete amplifier. Watch their ads & website for details.

the remote and the pot automatically rotates to its minimum position and the motor stops. Hit the button again and it returns to its original position. Don't want the pot to return all the way to its original setting? Easy – just hit one of the volume control buttons when the volume reaches the desired level.

A couple of LED indicators – "Ack" and "Mute" – are used to indicate the status of the Remote Volume Control. The blue "Ack" (acknowledge) LED flashes whenever an infrared signal is being received from the remote, while the orange "Mute" LED flashes while the muting operation is in progress and then remains on when the pot reaches its minimum setting.

So how does the unit remember its original setting during muting? Well, the microcontroller actually measures the time it takes the pot to reach its minimum setting. Then, when the Mute button is pressed again to restore the volume, power is applied to the motor drive for the same amount of time.

By the way, some readers may wonder why we did not incorporate the Digital Remote Volume Control published earlier this year, in the January & February 2007 issues. After all, it works well and has the advantage of an attractive blue LED digital display. The simple answer is that its distortion performance is not good enough to match that of the class-A amplifier.

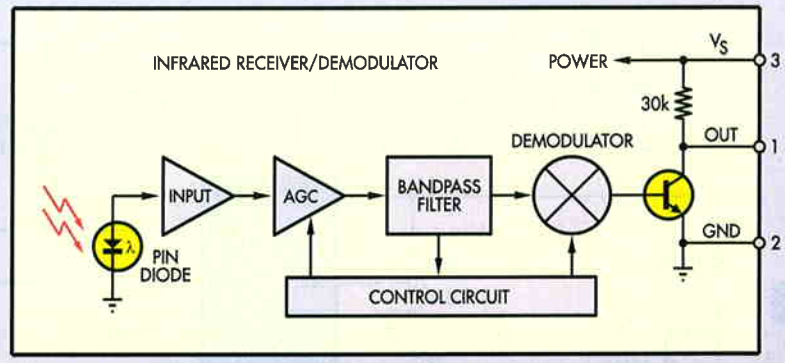


Fig.2: the IR receiver module used in the Remote Volume Control circuit contains a lot more than just a photo diode. This block diagram of the internals reveals an amplifier plus discrimination and demodulation circuits, all in the 3-pin package. After the 38kHz carrier is removed, the data appears on the "OUT" pin (1) ready to be processed by the micro.

Fig.3: this graph shows the frequency response of the whole amplifier (including the preamplifier), taken at a power level of 1W into 8-ohms. It's almost ruler flat from 10Hz to 20kHz and then rolls off gently to be -3dB down at about 100kHz.

Preamplifier circuit details

OK, so much for the background stuff. Let's see how it all works, starting with the audio preamplifier.

Fig.1 shows the circuit details, with just the left channel preamp stages shown for clarity, along with the power supply. The right channel preamp circuitry is identical to the left.

The audio signal from the source is AC-coupled to the input of the first op amp (IC1a) via a 4.7µF capacitor, while a 22kΩ resistor to ground provides input termination. In addition, the signal passes via a low-pass filter formed by a 100Ω resistor, a ferrite bead and a 560pF capacitor. This attenuates radio frequencies (RF) ahead of the op amp input.

IC1a operates with a voltage gain of 2 (+6dB) by virtue of the two 4.7kΩ feedback resistors. The 4.7kΩ resistor and 220pF capacitor combination roll off the top end frequency response, with a -3dB point at about 150kHz. This gives a flat response over the audio spectrum while eliminating the possibility of high-frequency instability.

Note, however, that the -3dB high-frequency point for the entire amplifier is about 100kHz – see Fig.3.

The output from IC1a (pin 1) drives one end of potentiometer VR1a (20kΩ) via a 22µF non-polarised coupling capacitor. The pot acts as a simple voltage divider and the signal on its wiper is fed to the input (pin 5) of op amp IC1b.

The wiper of the pot is also AC-coupled, this time using a 1µF non-polarised capacitor. This is done to prevent any DC voltage appearing across the pot, which if present would cause an irritating sound during wiper movement.

IC1b is used as a unity-gain buffer. This stage allows the preamp to provide a low-impedance output regardless of volume control setting. A 22µF non-polarised capacitor couples the audio signal to the output via a 100Ω resistor, which is included to ensure stability when driving the cable and amplifier input capacitance. This re-

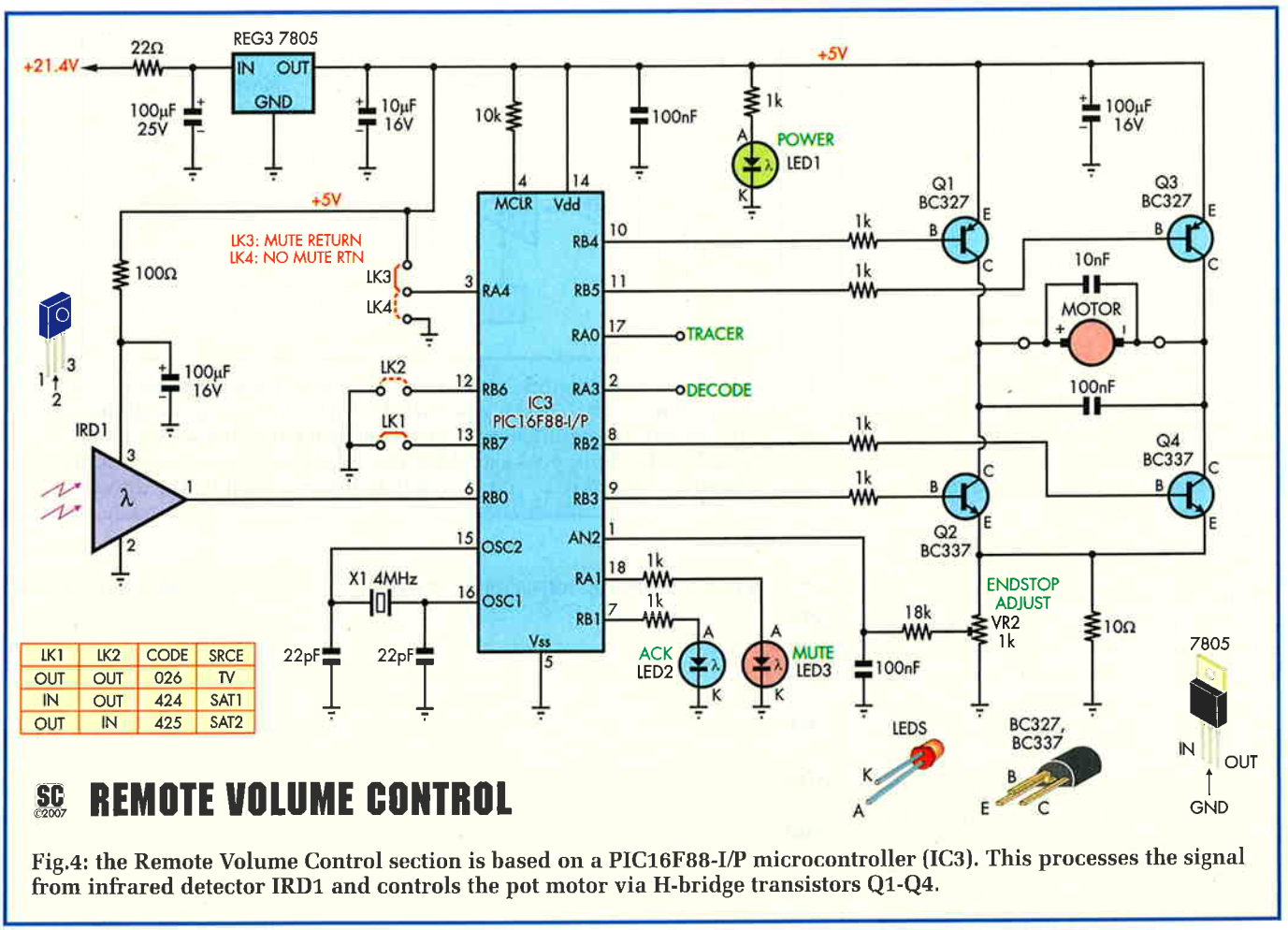


Fig.4: the Remote Volume Control section is based on a PIC16F88-I/P microcontroller (IC3). This processes the signal from infrared detector IRD1 and controls the pot motor via H-bridge transistors Q1-Q4.

sistor, together with the ferrite bead in series with the output, also helps to attenuate RF noise that might otherwise find its way back into the preamp circuit.

Power supply

Power for the circuit is derived directly from the ±22V terminals on the power supply board (described in June 2007). Diodes D1 & D2 provide reverse polarity protection, after which each rail is further filtered using a 220µF electrolytic capacitor. Two 3-terminal regulators – REG1 and REG2 – then provide ±15V supply rails to power the op amps.

In addition, +22V and 0V outputs are provided from the power supply (via a separate terminal block). These outputs are used to power the Loudspeaker Protector & Muting Module when the amplifier is finally assembled.

Remote volume control circuit

Now let's take a look at the circuit for the Remote Volume Control – see Fig.4. The three critical components are the PIC16F88-I/P microcontroller (IC3), the motorised potentiometer and an infrared receiver/detector module (IRD1).

In operation, the microcontroller monitors the demodulated infrared signal from IRD1. It then decodes this signal and drives the pot motor according to the RC5 code (see panel) sent by the handheld remote.

IRD1 only has three leads but it is not a simple device; in reality, it is a complete infrared detector and processor – see Fig.2. First, it picks up the 38kHz infrared pulse signal from the remote and amplifies this to a constant level. This is then fed to a 38kHz bandpass filter and then demodulated to produce a serial data burst at IRD1's pin 1 output.

From there, the demodulated signal from IRD1 is fed into IC3's RB0 input (pin 6). Operating under program control, the microcontroller then reconstitutes the demodulated data into byte-wide format using the Philips RC5 protocol specification.

Basically, the Remote Volume Control can be operated on one of three modes within the RC5 Code. These are TV1, SAT1 and SAT2 and the desired code is selected using jumper links LK1 & LK2 at the RB7 & RB6 inputs of IC3.

Normally, both these inputs are pulled high via internal resistors in IC3 but they can be pulled low using links LK1 & LK2. In operation, IC3 monitors these inputs and compares the selected code with the incoming serial data from IRD1. If the detected code is correct, the motorised potentiometer will be driven according to the pushbutton command sent by the remote control.

Motor drive

The motorised potentiometer is driven by four transistors (Q1-Q4) arranged in a H-bridge configuration. These in turn are driven via the RB2-RB5 outputs of IC3 via 1kΩ resistors.

The motor is off when the RB2-RB5 outputs are all set high. RB4 & RB5 turn PNP transistors Q1 & Q3 off, while

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RB2 & RB3 turn NPN transistors Q2 & Q4 on. As a result, both terminals of the motor are pulled low and so the motor is off. Note that the emitters of Q2 & Q4 both connect to ground via a common 10Ω resistor (more on this shortly).

The transistors operate in pairs so that the motor can be driven in either direction (to increase or decrease the volume). To drive the potentiometer clockwise, port RB3 goes low and turns off transistor Q2, while RB4 goes low and turns on Q1. This means that the lefthand terminal of the motor is taken to +5V via Q1, while the righthand terminal of the motor is held low via Q4. As a result, current flows through Q1, through the motor and then via Q4 and the 10Ω resistor to ground.

Conversely, to spin the motor in the other direction, Q1 & Q4 are switched off and Q2 & Q3 are switched on. As a result, the righthand motor terminal is pulled to +5V via Q3, while the left-hand terminal is pulled low via Q2.

The voltage across the motor depends on the voltage across the common 10Ω emitter resistor and that in turn depends on the current. Typically, the motor draws about 40mA when driving the potentiometer but this rises to over 50mA when the clutch is slipping. As a result, the motor voltage is around 4.5-4.6V due to the 0.4-0.5V drop across the 10Ω resistor (the rated motor voltage is 4.5V).

Current sensing & muting

Once the pot's wiper reaches its fully clockwise or anti-clockwise position, a friction-type clutch in the gearbox begins to slip. This prevents the motor from stalling, while also allowing the user to manually rotate the pot shaft if necessary.

The muting function depends on the microcontroller's ability to detect when the wiper is "on the stops". It does this by indirectly detecting the increase in the motor current.

In operation, VR2 samples the voltage across the 10Ω resistor when the motor is running. The resulting signal at its wiper is then filtered using an 18kΩ resistor and a 100nF capacitor (to remove the commutator hash from the motor) and applied to IC3's analog AN2 input (pin 1).

This analog input is measured (by IC3) to a resolution of 10-bits, or about 5mV. Provided this input is below 200mV, the PIC microcontroller allows the motor to run. However, as soon as voltage rises above this 200mV limit, the motor is stopped.

When the motor is running normally, the current through it is about 40mA which produces 0.4V across the 10Ω resistor. VR2 is used to attenuate this voltage and is adjusted so that the voltage at AN2 is slightly below the 200mV limit.

When the motor reaches the end of its travel, the extra load imposed by the slipping clutch increases the current and the voltage applied to the AN2 input rises above 200mV. This is detected by IC3 during muting and the microcontroller then switches the H-bridge transistors (Q1-Q4) accordingly to immediately stop the motor.

Note that AN2 is monitored only during the Muting operation. At other times, when the volume is being set by the Up or Down buttons on the remote, the voltage at AN2 is not monitored. As a result, the clutch in the motor's gearbox assembly simply slips when the potentiometer reaches its clockwise or anticlockwise limits.

Pressing the Mute button on the remote again after muting returns the volume control to its original setting. This is the "Mute Return" feature referred to earlier.

Note also that connecting IC3's RA4

Parts List

1 PC board, code 01208071, 201 x 63mm
1 Alpha dual-ganged 20kΩ log motorised pot (VR1) (Altronics Cat. R2000)
1 1kΩ (code 102) horizontal trimpot (VR2)
1 DIP 18-pin IC socket
2 DIP 8-pin IC sockets
5 2-way PC-mount screw terminal blocks, 5.08mm spacing (Altronics Cat. P2034A – do not substitute)
1 3-way PC-mount screw terminal block, 5.08mm spacing (Altronics Cat. P2035A – do not substitute)
1 4MHz crystal (X1)
4 ferrite beads (Altronics Cat. L5250A)
1 3-way SIL pin header, 2.54mm spacing
1 2-way SIL pin header, 2.54mm spacing
1 2-way DIL pin header, 2.54mm spacing
2 jumper links to suit headers
1 6.35mm panel-mount single-ended spade connector
1 6.35mm spade connector
4 M3 x 25mm tapped standoffs
4 M3 x 6mm screws
1 M4 x 10mm screw
1 M4 nut
1 M4 flat washer
1 M4 star washer
1 250mm length of 0.8mm tinned copper wire
1 150mm length of red hookup wire
1 150mm length of black hookup wire
2 100mm cable ties

Semiconductors
2 LM4562 op amps (IC1, IC2)
1 PIC16F88-I/P programmed with "Low Noise Preamp Volume.hex" (IC3)
1 infrared decoder (IRD1)
1 7815 15V regulator (REG1)
1 7915 -15V regulator (REG2)
1 7805 5V regulator (REG3)
2 BC327 PNP transistors (Q1,Q3)
2 BC337 NPN transistors (Q2,Q4)
1 3mm red LED (LED1)
1 3mm blue LED (LED2)
1 3mm orange LED (LED3)

Capacitors
2 220µF 25V PC electrolytic
1 100µF 25V PC electrolytic
4 100µF 16V PC electrolytic
4 22µF NP electrolytic
1 10µF 16V PC electrolytic
2 4.7µF NP electrolytic
2 1µF NP electrolytic or MKT polyester
5 100nF MKT polyester
1 10nF MKT polyester
2 560pF ceramic
2 270pF ceramic
2 22pF ceramic

Resistors (0.25W, 1%)
4 100kΩ
2 22kΩ
1 18kΩ
1 10kΩ
4 4.7kΩ
7 1kΩ
6 100Ω
1 22Ω
1 10Ω

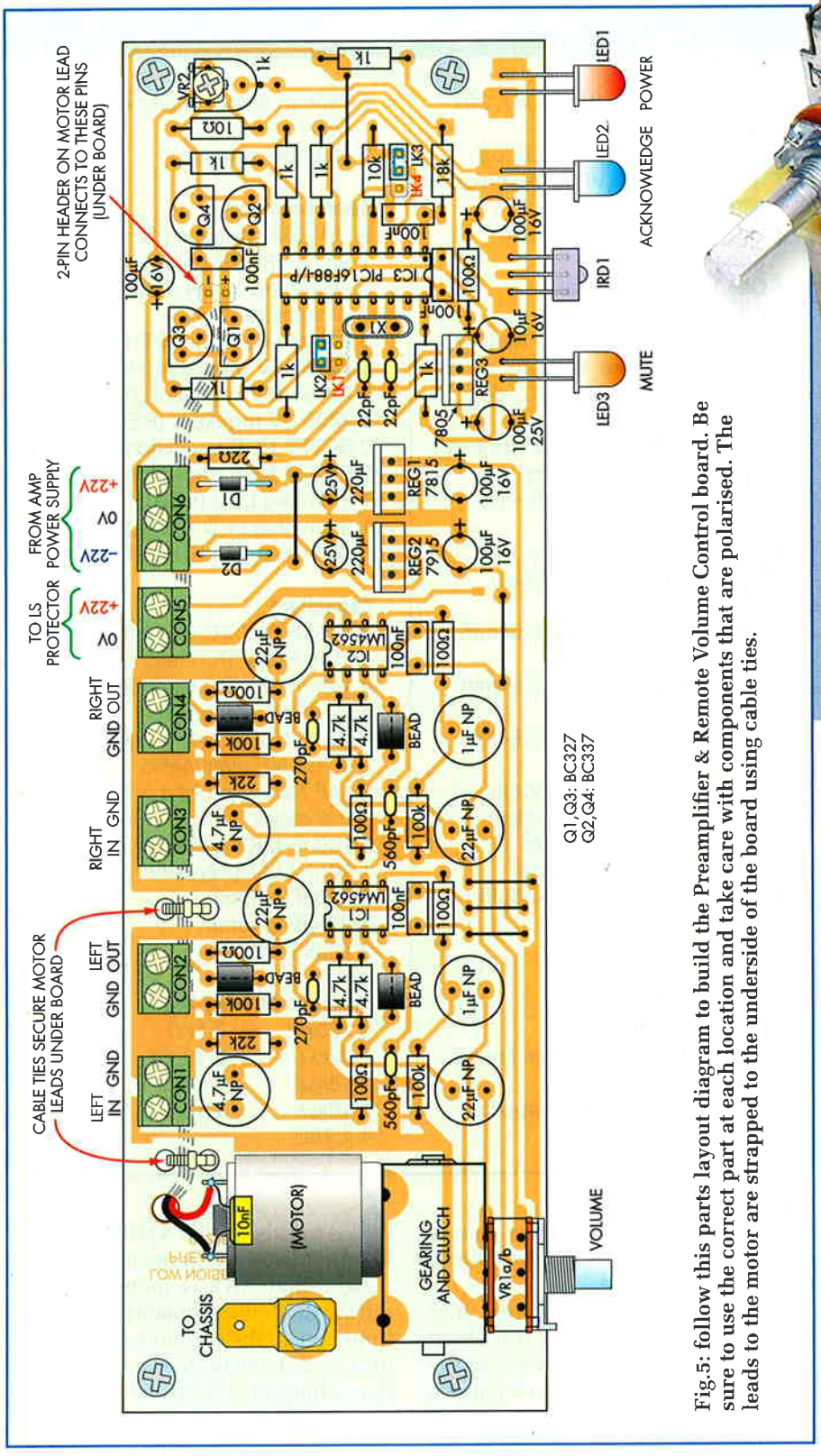
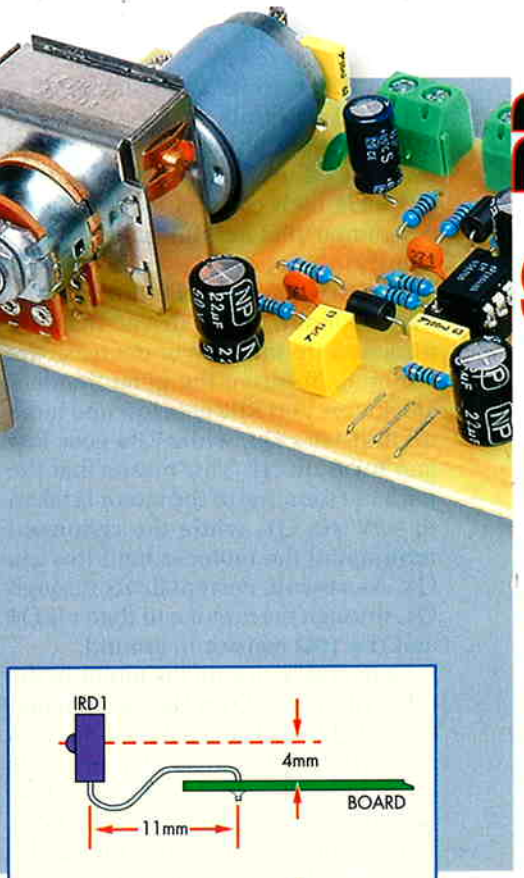


Fig.5: follow this parts layout diagram to build the Preamplifier & Remote Volume Control board. Be sure to use the correct part at each location and take care with components that are polarised. The leads to the motor are strapped to the underside of the board using cable ties.



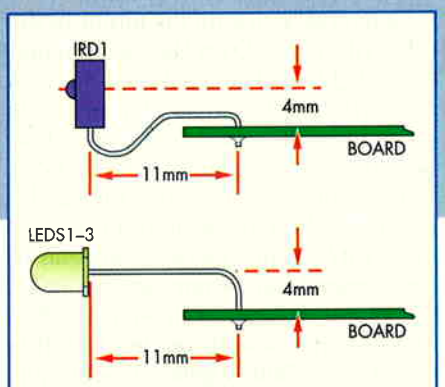


Fig.6: bend the leads for IRD1 and the three LEDs as shown here before installing them on the PC board. The centre line of each lens must be 4mm above the board surface.

input to ground via LK4 disables this feature. Conversely, to enable Mute Return, LK3 is used to pull RA4 to +5V.

Indicator LEDs

LEDs 1-3 indicate the status of the circuit. The red Power LED (LED1) lights whenever power is applied to the circuit and provides power on/off indication for the entire amplifier.

The other two LEDs – Ack (acknowledge) and Mute – light when their respective RB1 and RA1 outputs are pulled high (ie, to +5V). As indicated previously, the Ack LED flashes when ever the RB0 input receives an infrared signal from the remote, while the Mute LED flashes during the Mute operation and then stays lit while the volume remains muted.

Crystal oscillator

Pins 15 and 16 of IC3 are the oscillator inputs for 4MHz crystal X1, which is used to provide the clock signal. This oscillator runs when the circuit is first powered up for about 1.5 seconds. It also runs whenever an infrared signal is received at RB0 and then for a further 1.5 seconds after the last receipt of signal, after which the oscillator shuts down.

Note, however, that this shut down does not occur if a Muting operation is still in process.

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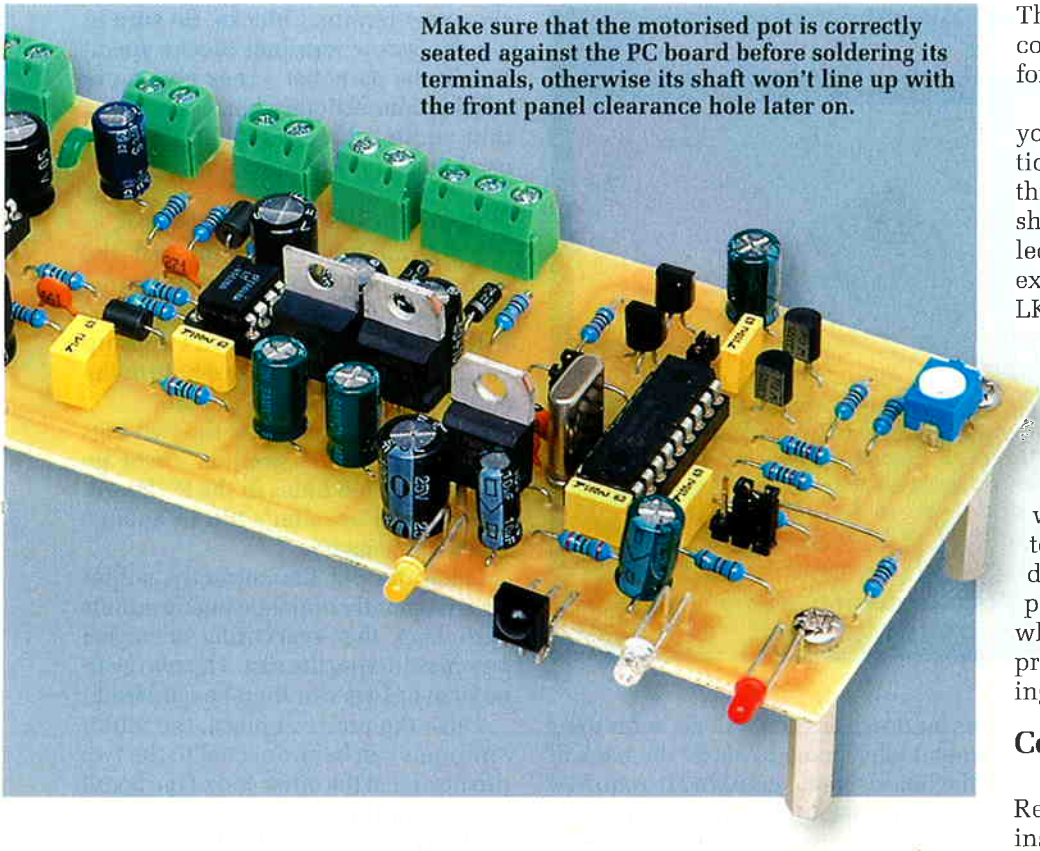

Make sure that the motorised pot is correctly seated against the PC board before soldering its terminals, otherwise its shaft won't line up with the front panel clearance hole later on.

Shutting down the oscillator in the absence of an infrared signal from the remote ensures that no noise is radiated into sensitive audio circuitry when the volume control is not being altered.

Waking up again

As just stated, when there is no IR signal from the remote, the circuit goes to "sleep" (ie, the oscillator shuts down) and so no noise is produced. However, as soon as it receives an IR signal, the circuit "wakes up" and drives the potentiometer. It then shuts down after about 1.5 seconds if it does not receive any further IR signals.

In addition, the motor is enclosed by a Mumetal shield which reduces any radiated electrical hash from the commutator brushes. A 10nF capacitor connected directly across the motor terminals also prevents commutator hash from being transmitted along the connection leads, while further filtering is provided by a 100nF capacitor located at the motor output terminals on the PC board.

Coding options

Links LK1 & LK2 at RB7 and RB6 are used to program the different infrared coding options. The default selection is when both RB6 and RB7 are pulled high via their internal pull-up resistors – ie, when LK1 and LK2 are out. This selects the TV1 infrared remote control code and this will be suitable for most applications.

However, this code may also operate your TV and so we have provided options to select another code to prevent this from happening. The table in Fig.4 shows the linking options used to select either the SAT1 or SAT2 code. For example, installing LK2 (and leaving LK1 out) sets the code to SAT2.

Power for the circuit is derived from the amplifier's 22V DC supply and is fed in via a 22Ω resistor and a 100µF decoupling capacitor. The resulting rail is then applied to regulator REG3 which produces a +5V supply rail to power IC3, IRD1 and the H-bridge driver stage for the motor. A 10µF capacitor decouples the output of REG3, while the 100µF capacitor across IRD1 prevents this device from false triggering due to "hash" on the 5V rail.

Construction

All the parts for the Preamp & Remote Volume Control Unit are installed on a single PC board coded 01208071 and measuring 201 x 63mm. The external connections to the power supply and to the audio input and output cables are run via insulated screw terminal blocks.

Fig.5 shows the assembly details. As usual, begin by checking the board for defects and for the correct hole sizes. In particular, check that the motorised pot and the screw terminal blocks fit correctly and that the mounting holes are correct.

That done, start the assembly by installing the six wire links. You can straighten the link wire by securing one end in a vyce and then pulling on the other end using a pair of pliers, to stretch it slightly. The resistors can

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	4	100kΩ	brown black yellow brown	brown black black orange brown
❑	2	22kΩ	red red orange brown	red red black red brown
❑	1	18kΩ	brown grey orange brown	brown grey black red brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	4	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	7	1kΩ	brown black red brown	brown black black brown brown
❑	6	100Ω	brown black brown brown	brown black black black brown
❑	1	22Ω	red red black brown	red red black gold brown
❑	1	10Ω	brown black black brown	brown black black gold brown

Avoiding An Earth Loop With IRD1

If the supplied infrared receiver (IRD1) includes an external metal shield (see photo), then steps must be taken to insulate it from the chassis when the preamplifier is installed. That's because the shield is connected to the centre (GND) terminal of the device and a short between the shield and the metal chassis would create an earth loop. And that in turn would inject hum into the audio signal.

One method is to attach a short strip of insulation tape to the inside of the front panel, with a hole cut out to match the hole in the panel. Alternatively, it should be possible to insulate the front of the device and arrange it so that it just stands clear of the front panel.

If your infrared receiver module has a metal shield like this one, then be sure to insulate it from the front panel as described in the accompanying text.

Do not rely on the powder coating on the chassis to provide insulation! That's asking for trouble.

then go in. Table 1 shows the resistor colour codes but you should also check them using a digital multimeter, as the colours can sometimes be difficult to decipher.

Next on the list are the four ferrite beads. These each have a wire link run through them, which is then soldered to the board. Follow these with the two diodes (D1 & D2), then install sockets for the three ICs. Make sure that each socket is oriented correctly (IC3 faces in the opposite direction to ICs 1 & 2) and that it's seated properly against the PC board.

In fact, it's best to solder two diagonally opposite pins of a socket first and then check it before soldering the remaining pins.

The MKT and ceramic capacitors can now go in, followed by the non-polarised capacitors and the polarised electrolytics. Make sure that the latter are all correctly oriented and note that the 100µF capacitor to the left of LED3 must be rated at 25V (the other 100µF capacitors can all be rated at 16V).

Now install the transistors and 3-terminal regulators. Transistors Q1-Q4 all go in the remote volume control section and must be oriented as shown. Be sure to use the correct type at each location. Q1 & Q3 and both BC327s, while Q2 & Q4 are BC337s. Don't get them mixed up.

The same goes for the three regulators. REG1 is a 7815, REG2 a 7915 and REG3 a 7805 – again, don't mix them up. These parts should all be inserted as far down as they will go, with their metal tabs facing towards the back of the board. No heatsinking is required for their metal tabs, since current requirements are only modest.

The 2-way DIL (dual-in-line) pin header for LK1 & LK2 can now be installed, followed by the 3-way header for LK3 & LK4. A 2-way pin header is also used to terminate the motor leads (just to the right of Q1 & Q3). To install this header, first push its pins down so that their ends are flush with the top of the plastic, then install the header from the component side and solder the pins underneath.

This will give about 7mm pin lengths to terminate the leads from the motor, which are run underneath the PC board.

Crystal X1 (adjacent to IC3) can be installed either way around. Make sure it's seated correctly before soldering its leads, then install trimpot VR2 and the six screw terminal blocks. Be sure to use the screw terminal blocks specified in the parts list – they give more reliable connections when terminating thin audio cable leads than the type used on our prototype.

Correction For Part 3

The left and right channel speaker inputs on the Speaker Protection module are each shown shorted at the relay pads in Fig.2 (p72) of last month's issue. These pads should NOT be joined.

A dodgy file conversion process that rotated these pads through 90° was responsible for this error. The PC board file sent to the kit retailers is correct – just follow the parts layout.

Mounting the motorised pot

It's absolutely critical to seat the motorised pot (VR1) correctly against the PC board before soldering its leads, If this is not done, it won't line up correctly with its clearance hole in the amplifier's front panel later on.

In particular, note that the two lugs at the rear of the gearbox cover go through slotted holes in the PC board. Use a small jeweller's file to enlarge these if necessary.

Once the pot fits correctly, solder two diagonally opposite pot terminals and check that everything is correct before soldering the rest. The two gearbox cover lugs can then be soldered.

Once the pot is in place, the motor terminals can be connected to the two pin header at the other end of the board using light-duty hook-up cable. These leads are twisted together to keep them tidy and pass through a hole in the board immediately behind the motor. As shown, they are then secured to the underside of the PC board using cable ties and connected to the header pins (watch the polarity).

Don't forget to solder the 10nF capacitor directly across the motor terminals. As previously stated, it's there to suppress motor hash.

Mounting the LEDs

Fig.6 shows the mounting details for the infrared receiver (IRD1) and the three LEDs. As shown the centre line of each lens must be 4mm above the board surface.

So how do you mount the LEDs accurately? Easy – just cut 11mm-wide and 4mm-wide templates from thick cardboard. The 11mm template serves as a lead bending guide, while the 4mm template is used as a spacer when mounting the LEDs – just push each LED down onto the spacer and solder its leads.

Hint: you can use sticky tape as a "third hand" to hold each LED and the template in place during soldering.

IRD1's leads should also be bent as shown in Fig.6 and the photos. This will allow a small amount of "give" in the leads when the lens later contacts the back of the front panel (ie, it will

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allow IRD1 to "spring" back slightly and keep the lens against the panel).

Finally, complete the board assembly by installing the quick connector. As with previous boards, it's held in place using an M4 screw, a flat washer, a shakeproof washer and a nut (see Fig.3, p74 last month).

Initial checks

Before plugging in any of the ICs, it's a good idea to check the supply voltages. However, if you don't have the power supply running yet (or a suitable bench power supply), this can wait until the final assembly in the chassis.

Assuming you do have a power supply, connect the +22V, -22V & 0V leads to CON6 and switch on. Now check the voltages on pins 8 & 4 of the two 8-pin IC sockets (ie, between each of these pins and 0V). You should get readings of +15V (pin 8) and -15V (pin 5) respectively.

Similarly, check the voltage on pin 14 of IC3's socket – you should get a reading between 4.8V and 5.2V.

If these voltages are correct, switch off and plug the ICs into their sockets, taking care not to zap them with static electricity. Note that IC1 & IC2 face one way while IC3 faces the other way.

Remote volume control testing

If you don't have a dual power supply, then you can check out the remote volume control section only using a single rail 9-15V supply (connect this between the +22V and 0V terminals on CON6). As before, check the voltage on pin 14 of IC3's socket (it must be between 4.8V and 5.2V), then switch off and plug IC3 into its socket.

In addition, insert the jumper link for LK3, to enable the Mute return feature but leave LK1 & LK2 out for the time being (to accept the TV code from the remote).

Further testing requires a universal remote control. These range from single TV remote controls with limited functions to elaborate models capable of operating many different types of equipment.

Note, however, that simple TV remote controls will only operate this project using the TV code (026). That can cause problems if you have a Philips TV set located in the same vicinity as the amplifier, as the remote control will probably operate the TV as well. This is easy to solve – just use a multi-item remote control so that a different code can be used (either 424 for SAT1 or 425 for SAT2)

An example of a TV-only remote control is the Jaycar AR-1703. Multi-item remote controls include the Altronics A-1009 and the Jaycar AR-1714.

Programming the remote

The best approach here is to initially program the remote control for a Philips brand TV (just follow the instructions supplied with the unit). In most cases, programming involves simultaneously pressing the "Set" button and the button for the item that is to be operated. In other words, press the "Set" and "TV" buttons together and enter a number for a Philips TV set.

In this case, the Altronics A-1009 uses the number 026 or 191 and the Jaycar AR-1703 uses 11414. If you are using a different remote control, just select a number for a Philips TV set. If you later find that this doesn't work, try another number for a Philips TV.

Having programmed the remote, rotate trimpot VR2 fully anticlockwise. That done, check that the motor turns the potentiometer clockwise when the remote's Volume Up and Channel Up buttons are pressed. It should travel fairly quickly when Volume Up is pressed and at a slower rate when Channel Up is used.

Now check that the volume potentiometer runs anticlockwise using the Volume Down and Channel down buttons. If it turns in the wrong direction, simply reverse the leads to the motor. Check that the blue Acknowledge LED flashes each time you press a button on the remote.

Next, set the pot to mid-position and hit the Mute button. The pot will rotate anti-clockwise and as soon as it hits the stops, the clutch will start to

Universal Infrared Remote Controls

The Remote Volume Control circuit is designed to work with most universal ("one-for-all") infrared remotes. It recognises the RC5 protocol that was originally developed by Philips, so the remote must be programmed for a Philips (or compatible) appliance before use.

Most universal remotes are provided with a long list of supported appliances and matching codes. To set the remote to work with a particular piece of gear, it's usually just a matter of entering the code listed for the manufacturer (in this case, Philips), as detailed in the instructions.

You'll also note that different codes are provided for TV, CD, SAT, and so on. This allows two or more appliances from the same manufacturer to be operated in the same room and even from the same handpiece.

This multiple addressing capability can be useful in our application, too. Normally, we'd program the remote to control a TV, as this works with the control module. But what if you already have a Philips TV (or some other model that uses the RC5 protocol)? Well, in that case, you simply use the SAT1 or SAT2 code instead, as the Remote Volume Control can also handle these!

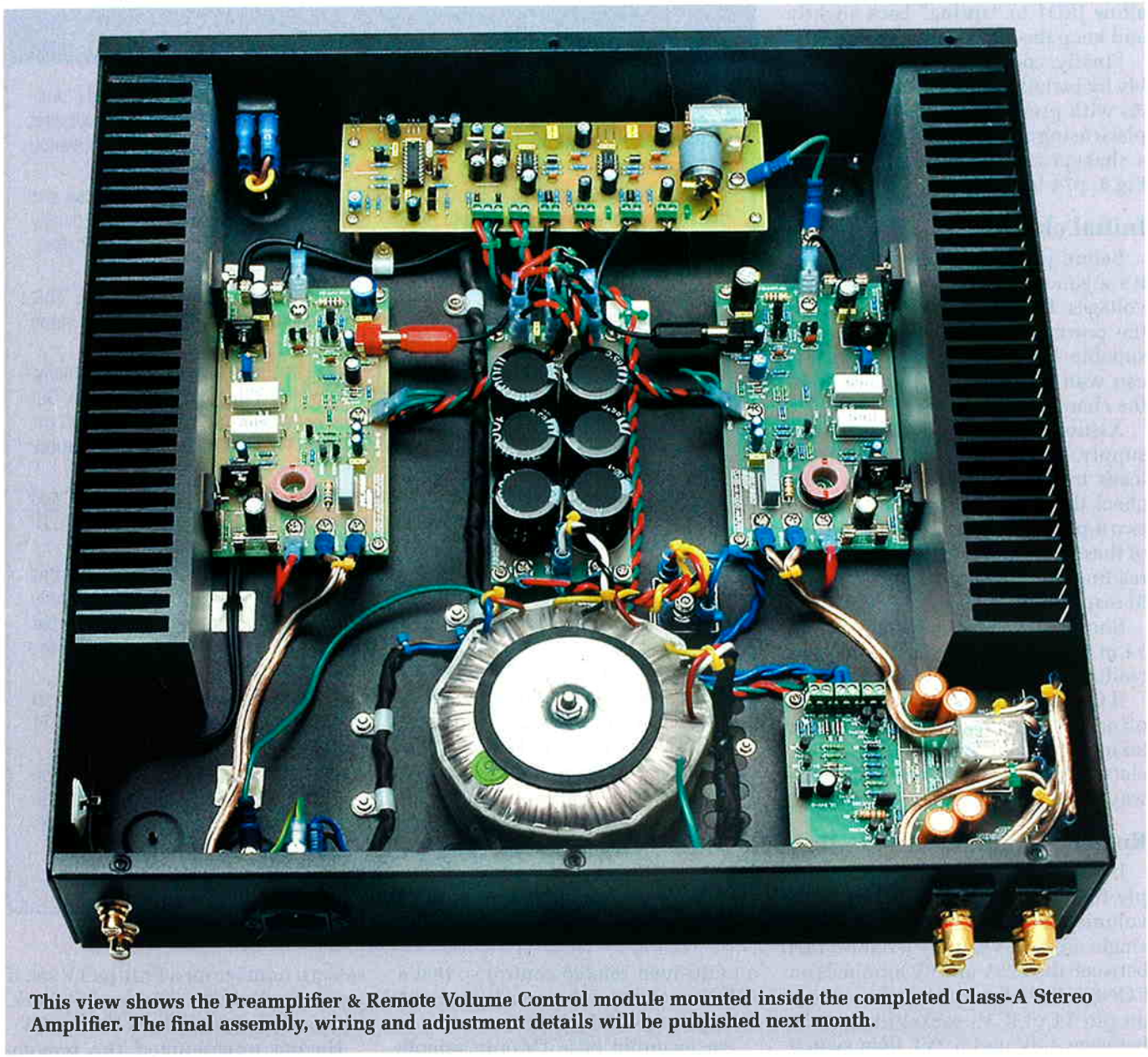
Typically, to set a remote to control a Philips TV, you first press and hold "SET" and then press "TV". This puts the remote in programming mode, as indicated by a LED, which should remain illuminated.

You then release both keys and punch in one of the listed Philips TV codes. For this project, code 026 works well. The red LED should then go out, after which the remote is ready for use. All universal remotes can be programmed in a similar manner but if in doubt, try reading the instructions! If the first code listed doesn't work with the Remote Volume Control, then try another.

Once the remote has been programmed, the Remote Volume Control must be set up to recognise the particular equipment address that you've chosen (either TV, SAT1 or SAT2). The details on how to do this are in the main text.

Although this project should work with any universal remote, we've tested the following popular models: AIFA Y2E (Altronics A-1013), AIFA RA7 (Altronics A-1009) and Jaycar AR-1703. For all these models, the set-up codes are as follows: TV = 026, SAT1 = 424 and SAT2 = 425.

Note, however, that the AIFA Y2E doesn't have a mute button.



This view shows the Preamplifier & Remote Volume Control module mounted inside the completed Class-A Stereo Amplifier. The final assembly, wiring and adjustment details will be published next month.

slip. While this is happening, slowly adjust VR2 clockwise until the motor stops.

Now press Volume Up to turn the potentiometer clockwise for a few seconds and press Mute again. This time, the motor should stop as soon as the pot reaches its minimum position.

Note that a programmed timeout of 13-seconds will also stop the motor (if it hasn't already stopped) after Mute is activated. This means that you have to adjust VR2 within this 13s period, otherwise the timeout will stop the motor.

If it stops prematurely or fails to stop at all (ie, the motor runs for the full 13 seconds), try redoing the adjustment. Once the adjustment is correct, pressing the Mute button a second time should accurately return the potentiometer to its original position.

As mentioned earlier, links LK1 & LK2 change the codes for the infrared transmission – see the table in Fig.4. You will only need to install one of these links (to select SAT1 or SAT2) if you have a Philips TV. Remove link LK3 and install link LK4 if the Mute return feature is not required.

Note that with a new motorised potentiometer, the clutch will require a little "wearing in" to evenly spread the lubricant in the slipping sections. This can be done simply by turning the pot shaft by hand a few times before use. Readjust VR2 for best results after you do this.

Finally, note that the power supply earth (0V) is *not* connected to the left and right channel earth tracks on the PC board. This avoids a hum loop, since the two channels are normally earthed back through the power amplifiers via their signal leads.

However, if you want to use the preamp on its own, *both* the left and right channel signal earths on the board must be connected to the 0V rail for the power supply. This can be done by connecting wire links between the screw terminal blocks.

That's all for this month. In Pt.5, we'll show you how to assemble all the modules into a custom metal chassis to produce a complete high-quality class-A audio amplifier. **SC**

siliconchip.com.au

ezi-TRAK GPS/GSM-based Vehicle Tracking System

The press release looked intriguing, telling of an Aussie tracking device helping to foil a car-jacking in Nigeria (see report at right). But (being the inquisitive creatures we are) we wanted to know the story behind the story. Just what is this "EziTRAK" and what makes it so special? Ross Tester explains.

We contacted the manufacturers of the EziTRAK system and they were most helpful in answering our questions.

In a nutshell, the EziTRAK is one of a family of similar products. This one's fundamental purpose is to protect your car from either theft or hijacking (there are also models for boats and bikes).

It can be used to remotely disable the vehicle and/or let you know where the vehicle is at any instant.

While there have been vehicle protection systems on the market for some time which do this, the EziTRAK goes about it a completely different way.

Instead of using wireless (or satellite) to go through a security monitoring base station (and that's not cheap!) EziTRAK uses the standard GSM (cellular) phone network to keep you in touch with your vehicle and gives you direct control via your phone.

It does this by using a dedicated phone SIM card to become what is effectively a mobile phone – but a mobile phone with just one purpose: vehicle security. Naturally, you must keep the SIM card in credit or the EziTRAK will not be able to dial out nor will you be able to contact it.

In the event of a pre-determined "event", the EziTRAK will dial your mobile phone number and let you know what the event is and where the vehicle is at that time. You have the choice of disabling the vehicle, locking the vehicle, etc.

It continually monitors the following functions:

- Intruder detection
- Panic button pressing
- Ignition detection
- Low (or disconnected) battery
- Tow-away (vibration or GPS)
- Over-speed detection

Any of these will trigger the unit into calling you and tell you not only what the "problem" is but also tell you where the vehicle is headed, its speed and so on.

At any time, you can also "call" the EziTRAK and poll any of this information from the unit's "black box" vehicle data recorder.

And if you have appropriate GPS map software in your PC, you can even have a real-time display of where the vehicle is and where it is going!

Hmm. Want to know where the sales rep is spending his time each day?

PRESS RELEASE

AUSSIE MADE EziTRAK HELPS FOIL NIGERIAN CAR THIEVES

Australian made and designed vehicle security and tracking system EziTRAK has been used in Nigeria to recover a stolen car after the driver was shot during a carjacking.

Earlier this month, a Toyota Camry was carjacked just before midnight in one of Nigeria's largest cities. The driver of the vehicle was shot in the process, and the thieves escaped in the stolen vehicle.

The vehicle was fitted with EziTRAK. Within minutes, the vehicle was tracked and immobilised some 13 km from where it was stolen. Using GPS coordinates from the EziTRAK unit, police were able to locate and recover the stolen vehicle.

The driver has been discharged from hospital and is recovering well.

But wait, there's more!

The EziTRAK can also work with your central locking system to give you "lost/locked-in key" unlocking.

The EziTRAK Micro is designed and manufactured in Australia by Rojone Pty Ltd (www.ezitrak.com.au) and sells for $985, not including installation.

With many of today's luxury cars approaching and into the six figure bracket, that seems to us to be cheap insurance. And speaking of insurance, with a system like this installed you're quite likely to qualify for a premium discount. SC

Inside the eziTRAK: centre top of the left photo is the SIM card holder.

At left is the complete eziTRAK Micro Vehicle Tracking System.

benchmark
AUGUST 2007

DICK SMITH ELECTRONICS
www.dse.com.au

DICK SMITH

Lab Power Supply 13.8V DC 23A

This laboratory grade switch mode power supply with solidly built metal casing provides well regulated 13.8V DC output with a 23A current rating. **Designed to be exceptionally immune to high levels of RF, it is ideal for powering radio transmitters and other high-current loads in engineering and servicing applications. Current: 23A continuous** (1 min, 50% duty cycle). Ripple & Noise: <5mV RMS Load regulation: <100mV (0 to 100% load) Cooling: Thermally switched in-built cooling fan. Size: 181 x 63 x 190mm (approx) Q1755

$99

Due Mid-August

NEW

DICK SMITH

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Laboratory grade linear style power supply with 0-30V adjustable output and an adjustable constant current setting from 0A to 2.5A at all selectable output voltages. Features separate voltage and current metering, overload protection and high/low current front panel terminals. Solidly built chassis, measures 150mm (W) x 235mm (D, inc knobs) x 145mm (H, inc feet). Q1770

$99

SAVE $50

DICK SMITH

18V Dual Speed Rechargeable Cordless Drill

Dual speed gearbox, electronic speed control with brake, 1hr mains-powered fast charger, 18V NiCd battery pack. 25 torque settings plus strong carry case. T4869

$59.99

DICK SMITH

24V Heavy Duty Cordless Hammer Drill

Two speed gearbox and smooth electronic speed control, large 13mm keyless chuck, 17 torque settings, carry case, 1hr fast charger. T4870

$69.99

DICK SMITH

24V Extra Heavy Duty Cordless Hammer Drill

Powerful Mabuchi brand motor, dual speed gearbox, electronic speed control, 90 min fast charger, 24V NiCd battery pack, front handle and rugged carry case. T4875

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DICK SMITH

3.6V Rechargeable Cordless Screwdriver

Adjustable angle (straight or pistol grip) with comfortable coated handle. Incl. chrome vanadium bits, forward/reverse direction switch, and AC charger. T4831

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16pc Slim Bit Set with Ratchet Handle

Uses 45mm long super-hard S2 grade 4mm Hex bits that are thinner than standard bits, allowing access to recessed screws in a wider range of equipment. Includes a reversible direction ratchet driver handle and bit storage holder. T6333

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DICK SMITH

32-Piece Super-Hard Security Bit Set

Super-hard S2 grade steel alloy bits (HRC58-62) provide a much longer useful life, especially in heavy-duty applications. The set includes: Torx set bits, Security Hex bits, Tri-wing bits, Spanner pin drive bits, a magnetised bit holder, all in a soft plastic storage case. T4514

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DICK SMITH

Hobby Mini Vice

Sturdy and lightweight, this metal Vice fits easily to a workbench or table up to a thickness of approx 30mm. Made from aluminium alloy for strength and durability, its jaws are 60mm wide and open to a max of 50mm. T4747

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DICK SMITH ELECTRONICS

28 Range Digital Multimeter

This 3.5 digit meter provides a large LCD screen, transistor and diode tests, a continuity buzzer, high input impedance, low battery indicator, capacitance readings plus a Sleep mode to reduce battery consumption. Supplied with test leads and holster. Q4139

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INTRODUCTORY PRICE REVERTS TO $39.99 ON 1/8/07

RED HOT PRICE

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10MHz Single Channel Oscilloscope

An economical and easily transportable Oscilloscope with bandwidth of up to 10MHz and Vertical sensitivity up to 5mV/DIV. Easy to operate, it's an ideal instrument for a wide range of hobby and educational uses. Supplied with a 1:1 & 10:1 switchable CRO probe, tiltable carry handle and detailed instruction manual. Q1803

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40pc Hobby Rotary Tool Kit

This 130W high-speed mains-powered rotary tool is a multi purpose unit that is able to cut, drill, polish, grind, sand and engrave. Includes storage case, pencil grip extension shaft, collets, grinding, engraving, sanding, drilling and buffing attachments. Variable speed, approx 8,000 to 30,000rpm. T4823

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GREAT VALUE

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Gets at dust in hard to reach places without leaving residue or moisture. Great for cleaning PC keyboards and camera lenses. N0055

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Solidly built and well finished plastic toolbox with a removable internal tray, fold-out storage in the lid and 30kg max capacity. H4597

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SAVE $7

digitor

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This economical kit provides a wide range of crimp style terminals and a standard crimp tool, all stored in a plastic component case. See www.dse.com.au for a list of included terminals. H5061

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DICK SMITH ELECTRONICS

SAVE 40% AUGUST ONLY SPECIAL

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High conductivity, low loss Fig 8 Oxygen Free Copper (OFC) cable with ultra-flex translucent PVC insulation, and tinned copper conductors on one side of the Fig 8 flex to aid in polarity identification / matching. Conductors: 30 x 0.12mm OFC, cross-sectional area: 0.34mm². Price per metre. W2008

Full details online at: www.dse.com.au

$0.48/m

SAVE 40% OFF NORMALLY $0.80/m AUGUST ONLY SALE

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digitor

Video Adaptor SCART Plug - Component

SCART Plug to Component RGB Adaptor Directional Audio-Video adaptor fitted with a SCART plug (21 pin connected) and 3 RCA sockets RGB type (CrCbY) Gold plated low resistance connectors. Compact and ergonomic design. Easy and convenient connection and use. Converts AV signal to RGB input/output Color coded connections for component RCA cable interconnection. Used in all modern AV equipment which requires component cable conversions such as DVD, TV, STB or AV amplifiers & receivers. P6676

$14.98

SAVE $8

SAVE 33% OFF NORMALLY $1.48/M. AUGUST ONLY SPECIAL

Figure-8 Heavy Duty Power Cable

Red and black coloured PVC insulation polarity indication Rating: 50V DC, 17A maximum Conductors: 26 x 0.3mm Cross-Sectional Area: 1.8mm Applications: Power supplies, automotive, motorcycles, communications equipment (CB, HAM), spotlamps and wherever DC power is involved up to 17 amps. W2025

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SAVE $0.50/m

SAVE 40% USE FOR 240V AC POWER CORD OR AS A HEAVY DUTY SPEAKER CABLE

Light-medium Duty Fig 8 Lampcord Cable

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SAVE $2.25/pack

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Blowout Indicator Blade Fuses Pack of 10 from 3 to 15Amps

Pack of 10 mixed values ATC Blade Fuses with Blown Fuse Indicator LED. Each pack consists of two of each 3, 5, 7.5, 10 and 15 amp fuses. P9617

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SAVE $4.48/pack

SAVE 50% AUGUST ONLY SPECIAL

Blowout Indicator Fuse Blade Pack of 10 from 15A to 35A

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NEW

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SANYO

Eneloop Battery Charger with 4 x AA Ready To Use Eneloop Batteries

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DSE

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DICK SMITH

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Plug into the cigarette lighter socket in your car to provided 230V AC power for most smaller electrical equipment. M5150

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DICK SMITH

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Provides mains power for electrical equipment (notebooks, mobile phones, digital cameras, hi-fi's etc.) from your vehicle. M5300

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GREAT VALUE!

DSE

Escape Robot Kit
Works just like an A.I. robot it never fails to find its way out of a maze! The Escape Robot makes use of 3 infrared emitting diodes and 1 infrared receiving module to send/receive signals and detect obstacles. Has an in-built microprocessor, which enables it to think on its own. Requires solder and tools. K1233

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SAVE $10

CLAP YOUR HANDS AND THE ROBOT WILL FOLLOW

Follow Me Robot Kit
Clap, and the Robot will respond and move in the direction of the sound, has easy to build parts that are simple to put together, no soldering required. K1178

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Wireless FM Microphone Kit
Small enough to fit inside a matchbox, Incredibly stable and sensitive circuitry. Use it to monitor your baby, a distant telephone, or as a one way intercom. Signals are transmitted at around 90MHz on any FM radio. Requires 3 to 9V DC only. K5006

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Discovery Series Kit Multi-Timer Module
Timing module range between 0.1 sec. and 19.4 days. Can be configured for single cycle operation or for continuous repeat until reset. Power source required: 9V - 12V DC. Supplied with components and PCB. Case optional. K2807

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Carbon Monoxide Alarm Kit
This circuit has a two level CO concentration alert:- 1. Warning level that flashes an LED, 2. Alarm level, the LED is fully switched on and the relay output triggered. Momentary or toggle relay operation. Operates from 12V DC and kit is supplied with all specified components and hardware, printed circuit board (PCB), a pre-punched and screened metal panel, plastic case and a small satellite PCB which allows the constructor to mount the CO sensor remotely. K4614

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LIMITED STOCK!

MECCANO

Interactive Robot
Build 3 fantastic models from this single kit, download movements and sound from the web via USB, incl. a motorised construction tool which changes into the models motor. K1278

$89
SAVE $40

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

Traffic indicator works from 12V or 24V

This circuit is a lot more complicated than the conventional thermo-mechanical switch unit used in cars but has been included to show the amount of logic required to provide the same function.

Three optical interrupters are operated by a slotted disc attached to the steering wheel. When blocked, their collectors are held high by the 10kΩ resistors and because the outputs of IC5a & IC5d are normally high, the inputs to the gates of IC6a, IC6b, IC6c & IC6d are high, so that their outputs are low. The outputs of IC4b & IC4c are also low; hence the output of IC3c is low.

This makes all the inputs to IC1d & IC1b low so that their outputs are high. Because one input of IC1a & IC1c is now high, then their outputs are low. With both inputs of IC3c low then its output is low. The same situation applies to IC3a and the indicators (relays) are off.

When the indicator switch is operated, one input to IC5d (or IC5a) goes high so that its output goes low. This means that one input to both IC6c & IC6d (or IC6a & IC6b) goes low, sending their outputs high and therefore one input of both IC2a & IC2c high, making their outputs low. With both inputs of IC3a now low, its output is also low, effectively turning off the indicator lights for the other direction if they happen to be on.

Cancel pushbutton

The cancel pushbutton (switch S1) works the same way, in that it pulls the other input of IC5d (IC5a) high. The operation of the indicator switch also sends one input of IC3c (or IC3a) high so that its output goes high. In turn, one input of both IC1b & IC1d goes high, so that both their outputs go low.

This puts all the inputs of both IC1a & IC1c low, making their outputs high. This makes the inputs of IC3c high and so its output goes high, turning on the indicator lights via transistor Q2 and RLY2. Pin 5 of IC1b also goes high, keeping its output low. Also the input to IC4c goes high, making its output high to keep one input of IC1d high and its output low. So both IC1b & IC1d stay in this state when the indicator switch is released (open) so that the indicator lights stay on.

There are latches to make the optical interrupters directional. If the steering wheel operates Opto1 first, then IC6a's output goes high (one input low) making one input of IC1c high and it's output low but the lights stay on via IC1a, IC3d & IC1b.

When the steering wheel operates Opto2, the output of IC6b goes high, making the input of IC1a high and its output low. Now with both inputs of IC3c low then its output goes low and turns the lights off. If Opto2 is operated first, as when the wheel is turned in the direction you are indicating to turn, then IC6b's output goes high, sending one input of IC1a high so that its output goes low, but this does not affect IC3c. As its other input is high, then its output stays on.

By the time the wheel operates Opto1, Opto2 will have been blocked again so that IC1a returns to the same state as before, keeping the indicators going. However the output of IC1c will be made low by the output of IC6a going high. In turn, the output of IC4c goes low, in turn making one input of IC1d turn low, sending its output high so that the output of IC1c stays low even after Opto1 is blocked again.

IC4d allows for any number of steering wheel turns. In this case, when the wheel goes all the way around, then Opto3 is operated, to make one input of IC4b high. This together with the other input being made high by IC3c means that its output is made high. This makes one input of IC3d high, doing the same job as the indicator switch and so resetting the latch that uses IC1c. The other direction works in exactly the same way.

Ron Groves is this month's winner of a Peak Atlas Test Instrument

Only one optical interrupter can be unblocked at a time. The centre interruptor (Opto2) must be unblocked when the steering wheel is in the straight ahead, while the other optos are placed equally on either side. They need to be placed so that they provide cancellation when the steering wheel is turned back by a reasonable amount; eg, after exiting a corner.

Indicator switch

The indicator switch (S2) consists of a piece of thin tube pivoted at one end with a couple of compression springs to keep it central and with a microswitch placed on either side so that one is closed when the lever is pushed up and the other when the lever is pushed down. A rod inserted into the tube, with a knob on it, operates a third microswitch when it is pushed in, to act as the cancel button (S1).

While the relays select the left or right-hand indicator lights, the flashing function is performed a multivibrator based on transistors Q3 & Q4. Q4 is connected in Darlington fashion to Q5 and power transistor Q6 which then drives the indicator lamps. Diodes D3 and D4 feed the same 24V through to the piezo buzzer (which has an inbuilt oscillator) via the 680Ω current limiting resistor.

The circuit may be run from 12V by omitting the 7812 regulator and changing the relays to 12V types.

Ron Groves,
Cooloola Cove, Qld.

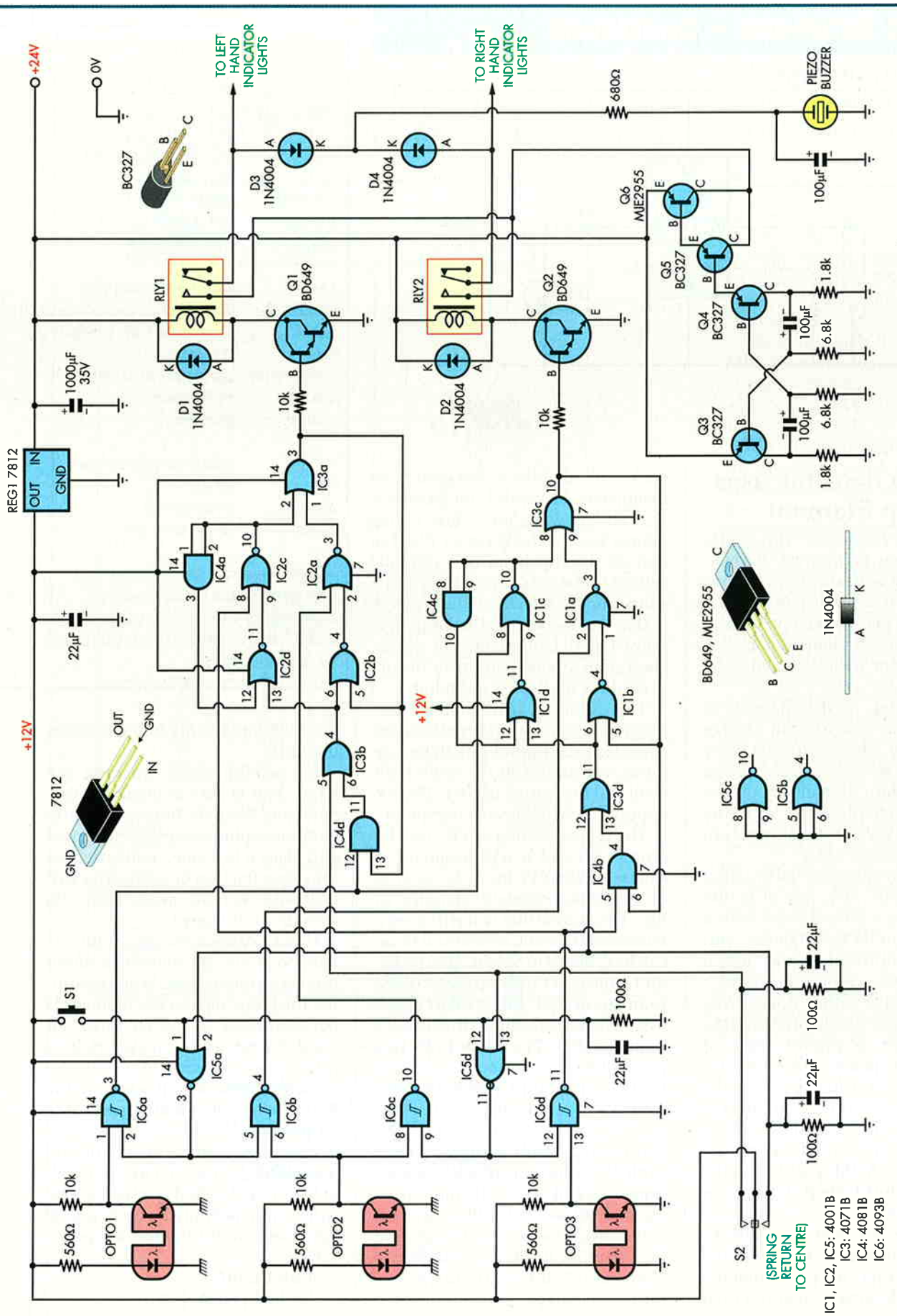
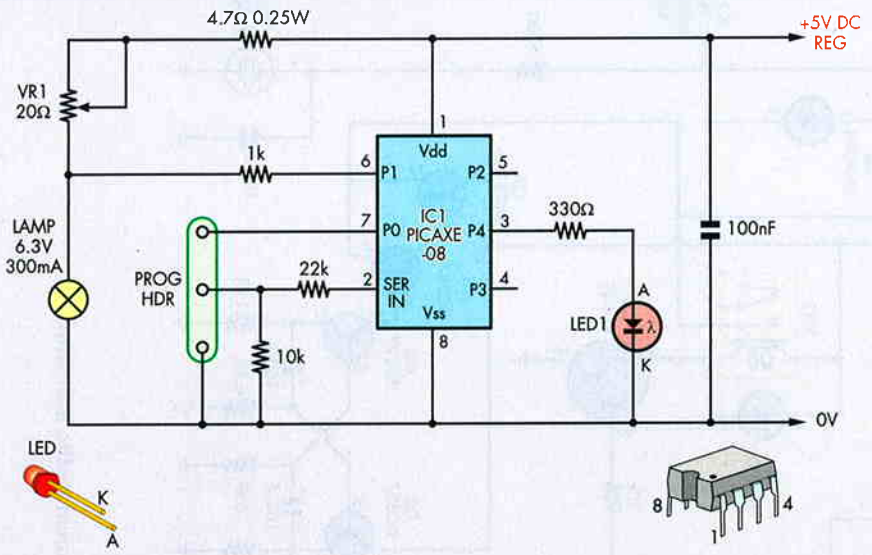


Fig.1: quite a lot of logic circuitry is required to duplicate the functions of a conventional thermo-mechanical traffic indicator.



Air flow detector uses hot lamp filament

This circuit can detect very gentle air movement or may be desensitised to cope with stronger air flow. The sensor is a torch lamp which has had the glass envelope broken off. The exposed filament acts as a heated resistor which is cooled by the moving air.

Any cooling of the filament is manifested as a significant change in resistance which is detected by the PICAXE as a change in voltage across the lamp. Depending on the setting of potentiometer VR1, the PICAXE then sets its P4 output (pin 3) high to turn on LED1.

The sensed voltage is fed to a high resolution ADC (P1, pin 6) in the PICAXE. The software starts with a brief pause to let the filament temperature stabilise, then goes into a loop to detect a certain threshold.

Calibration is either done using the preset pot or preferably, using the software. The pot should be set for maximum resistance before applying power (so you don't burn out the filament). Power up the circuit and the LED should light, then reduce VR1's resistance slowly until the LED turns off. At this point, blowing gently over the filament should turn the LED back on.

Alternatively, set the pot to maximum resistance and turn the circuit on. Adjust the pot so that the filament is glowing orange and then back it off slightly so the glow just disappears; be careful, the filament will still be very hot. Then using debug, look at the value in Word 0 and set the trip point to a suitable setting in the calibration line of the software. The benefit of this method is that you are setting the lamp to a known, high temperature, at which cooling is almost certain to occur, even if the air flow is quite hot.

This circuit is unsuitable for battery-operation as the current can be expected to be around 150-200mA or more, depending on the torch bulb used and the setting of VR1. The 5V supply can come from a computer.

The typical setting of VR1 will be around 5Ω and it will dissipate in excess of 200mW from the section of resistance element actually in use. This means that you will need a wirewound potentiometer and these can be difficult to obtain. Two possibilities are a 5Ω 15W wirewound pot from Jaycar (Cat. RP-3975) or a 10Ω 3W pot from Dick Smith Electronics (Cat. R-6903). The torch bulb was from Dick Smith Electronics (Cat. P-8185 or P-8150). Other bulbs with similar ratings are also suitable.

As shown, this circuit is very simple and merely turns on a LED. With the addition of a Darlington transistor and a relay, it could drive other devices. If the PICAXE 18X was substituted, the concept could be extended to drive a display to show rate of air flow. (Editor's note: the basic concept could also be used with a simple comparator to drive the LED).

Be careful when breaking the lamp, as it is easy to break the filament too. Wrap the bulb in paper (to eliminate splinters hitting your eyes) and place it in a vice. Gently tighten the vice a fraction of a turn; you will hear and feel the glass break. Be careful – it is sharp!

Use a coarse mesh cover for the lamp to protect the filament without hindering the air-flow. When mounting the lamp, ensure the filament is perpendicular to the air flow, not parallel to it, as this makes quite a difference to sensitivity.

Note that the circuit is unsuitable for use where flammable gases may be present. In other words, do not use it in the presence of volatile and flammable fluids such as petrol, alcohol or methylated spirits, acetone (present in nail polish or nail polish remover), paint thinners, kerosene, LPG, etc.

Brett Cupitt,
Ashfield, NSW. ($40)

Software Listing

```
;Air flow movement detector
;Designed for a PICAXE-08M

Delay:                  ;delay to let bulb filament stabilise
low 4                   ;ensure output is low
for b10=0 to 8          ; count to 8 (seconds)
pause 1000              ;pause a second
next b10                ;do it until time is reached

sense:                  ;main voltage drop sensing routine
readadc10 1,w0          ;read V at R4, convert to numeric value, place in W0
;debug w0               ;read sensed value in W0 - for calibration only
low 4                   ;set output low
If w0<635 then flow     ;calibration point. Jump if lower than 635
pause 20                ;wait 20 milliseconds
goto sense              ;goto beginning

flow:                   ;routine for showing air-flow present
high 4                  ;light LED
pause 20                ;wait 20 milliseconds
goto sense              ;start cycle all over again

;The calibration value may be altered. 635 is a central value.
;Increasing this will increase sensitivity and reducing it
;desensitises the circuit. This value may vary between different
;circuits. Use debug to see best what values the circuit is reading
; and what value you should use.
```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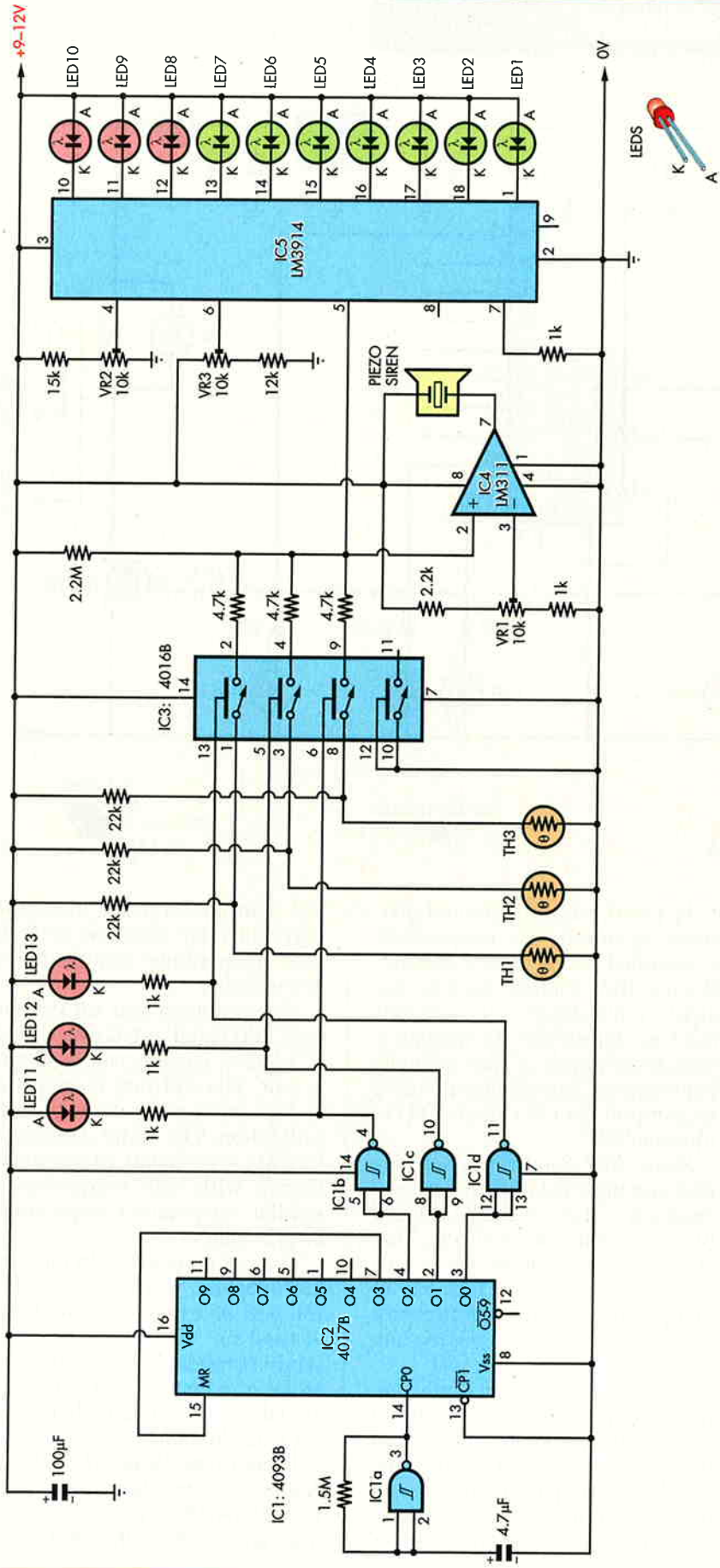


Alarm monitors up to nine freezers

This freezer monitor and alarm was designed to monitor three freezers placed next to each other but could be expanded to as many as nine.

The temperature of each freezer is monitored with a 10kΩ thermistor (Jaycar Cat. RN3440) sealed in a steel tube with neutral cure Silastic.

These are each in series with a 22kΩ resistor from the positive rail. The generated voltage is monitored with a LM3914 and 10-segment bargraph display.

The REF_{LO} and REF_{HI} voltages are set using potentiometers so that the display range corresponds to the estimated voltages generated over the temperature range of -20°C to +10°C.

These were calculated from the data sheet for the thermistor but could just as easily be measured experimentally. Pin 9 of the LM3914 can be left unconnected for dot mode display.

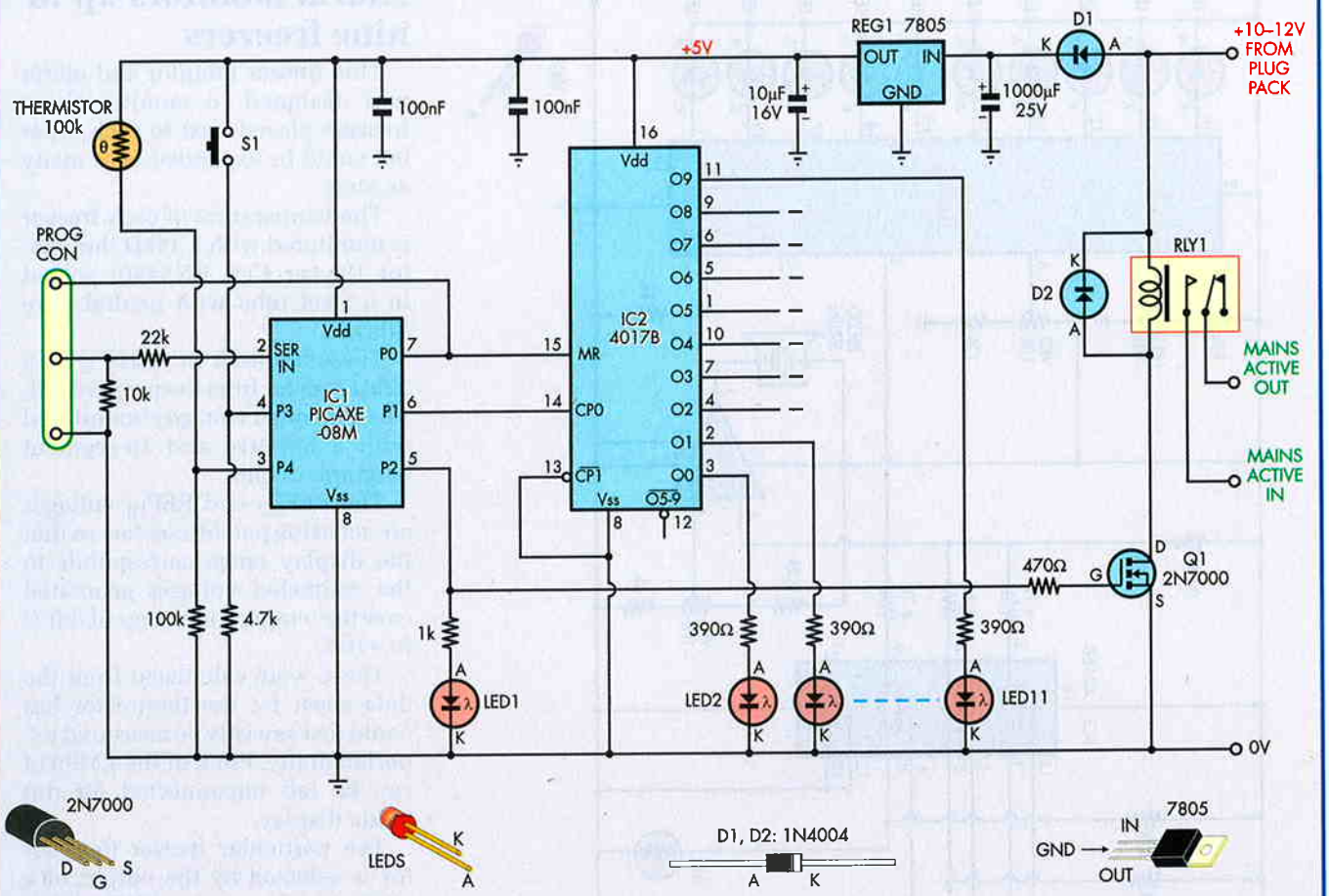
The particular freezer thermistor is selected by the output of a 4017 decade counter (IC2) which is clocked by a Schmitt trigger oscillator based on IC1a (4093) and operating at about 1Hz.

IC2's O0-O2 outputs drive inverters IC1b-IC1d and their outputs go low in turn to turn on the appropriate 4016 switch and a LED, to indicate the selected device.

A Sonalert beeper can be activated when any inputs exceeds the set temperature, which is monitored by an LM311 comparator (IC4).

Since all generated and reference voltages are derived from the power supply, the precise voltage is not important.

Graham Jackman,
Oakleigh East, Vic. ($40)



PICAXE thermostat for a 240VAC heater

Cheap fan heaters have a poor thermostat or none at all. This PICAXE-based thermostat uses a thermistor (DSE Cat. R1895) as the sensing device. Display of current temperature and set-point is via a 10-LED bargraph driven by a 4017 decade counter (IC2). Adjustment of the set-point is done using a single pushbutton switch (S1) and the load is switched by a 240VAC-rated relay.

Power for the circuit is provided by an external DC plugpack via a 7805 5V regulator. The external plugpack is simpler and safer to use and eliminates a source of self-heating that could confuse the operation of the circuit (small transformers get quite warm even if lightly loaded). In the prototype the thermistor was installed through the top of the box with short connecting wires.

To avoid relay chatter and give some hysteresis, the temperature is sampled about once a minute. During this waiting period, the 4017 is constantly clocked and reset as appropriate to display a pseudo-bargraph of the ambient temperature. This display is easier to interpret than if a single LED is illuminated.

Since only one LED is actually lit at any time, the brightness of the bargraph reduces as more LEDs are lit, due to reduced duty cycle. This also means that power consumption is correspondingly low. A brief flicker of the bargraph is seen once a minute when the PIC08M is reading the temperature.

When the pushbutton is pressed, the current set-point is displayed (as a single LED) and if the button is held the set-point increments slowly and wraps around to restart the count from the bottom. If the displayed ambient temperature is less than the set-point, the output LED and relay turns on until the next temperature sample (about one minute).

The prototype was set up with each LED equal to 1°C over a range of 16-25°C but this can be altered to suit. The software is annotated and includes a test mode to assist calibration. The 10-bit ADC in the PIC08M gives about 10 counts per degree with this thermistor, so smaller temperature steps would be possible.

The mains relay is driven via a 2N7000 FET. The relay's contact life will be extended if the heater is used on "low" setting; ie, just one heating element instead of two. Make sure that the relay's contacts are adequately rated to do the job.

Craig Simmons,
Lemon Tree Passage, NSW. ($45)

Note: the software listing is too long to include here but can be downloaded from ***www.siliconchip.com.au***.

White LED touch light

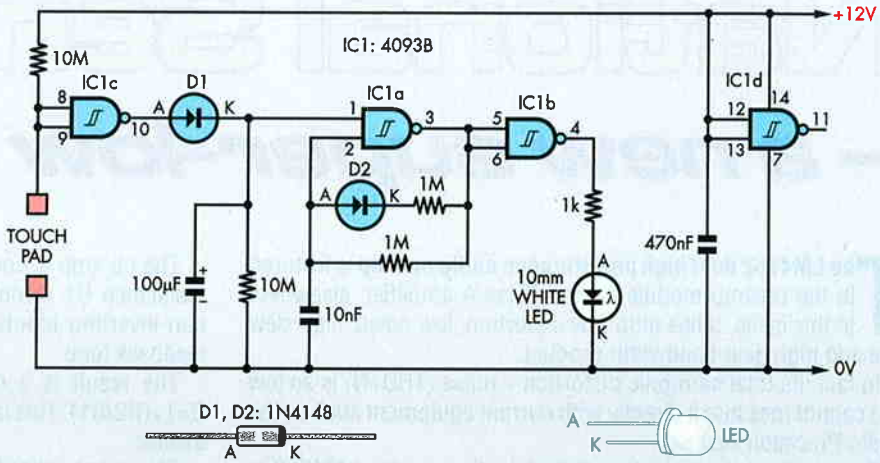
This white LED touch light circuit uses a 4093 quad NAND Schmitt IC. IC1a is a pulse generator with a one-third duty cycle and it drives the LED via a second gate, acting as a buffer. The reduced duty of the LED represents a two-thirds power saving, taking advantage of persistence of vision – ie, the human eye's inability to discern pulses above a certain frequency.

The LED circuit is gated by IC1c. It senses the resistance of a finger on its touch pad and then charges a 100µF capacitor via diode D1. This serves as a timer function to provide about five minutes' light.

The timing period may be altered by altering the value of the 100µF capacitor. The inputs of the spare gate - ie, pins 12 & 13 of IC1d – are "tied high" to conserve power.

On standby, the circuit uses well under 1µA. The LED and 1kΩ resistor could be replaced with a piezo sounder to provide a timed beep. In this case, the 10nF capacitor at pin 2 of IC1a controls the pitch.

Thomas Scarborough,
Cape Town, South Africa. ($35)



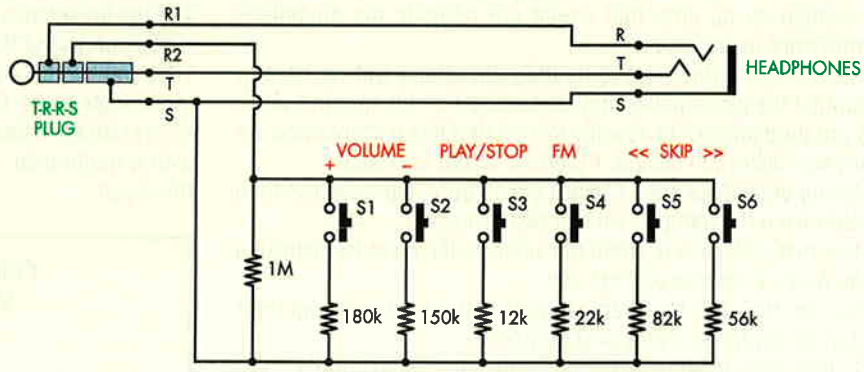
MP3 player remote control

This circuit was devised to provide a wired remote control that connects in-line with the headphones. The headphone socket on a Creative Zen-V MP3 player has an extra contact (a second ring R2) that is pulled up internally to 3V. This is the control pin and is normally shorted to GND (sleeve) by the headphones. Connecting a resistor between the control pin and GND creates a voltage divider that is detected by the internal sensing circuit.

This remote control circuit simply switches different resistor values, so that the voltages range from about 0.3V to 2V. It could be built as an inconspicuous remote, since suitable microswitches and the 4-pole headphone plug (Cat. PP-0138) are available from Jaycar.

Note: this circuit was devised to suit the Creative Zen-V MP3 player but other models and brands probably work in a similar way.

Placid Talia,
Oakleigh, Vic. ($30)



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National Semiconductor – a new super-low distortion

The LM4562 dual high performance audio op amp is featured in the preamp module for the Class-A amplifier, elsewhere in this issue. It has ultra-low distortion, low noise, high slew rate and high gain-bandwidth product.

In fact, its total harmonic distortion + noise (THD+N) is so low you cannot measure it directly with current equipment such as the Audio Precision Test Set!

Even without its super-low distortion figures, the LM4562 is an impressive op amp. Its typical input noise density is 2.7nV/√Hz while slew rate is quoted at ±20V/μs.

Gain-bandwidth product is 55MHz and open-loop gain is 140dB for a 600Ω load. In addition, it has excellent figures of 120dB for PSRR (power supply rejection ratio) and CMRR (common mode rejection ratio).

But it is the harmonic distortion performance that made us pick it as the only suitable op amp to be teamed with the new 20W Class-A amplifier current being featured in the magazine. We wanted an op amp that would not degrade the amplifier's performance in any way.

The LM4562 turned out to be the right choice but we have to admit that the preamplifier module featured in this month's issue was our third attempt to actually extract that fine performance. As in any low distortion design, PC board layout is critical.

Having obtained a great performance figure, typically less than .0005% from the module, we had two problems:

One, that distortion is about the same as the residual distortion of the Audio Precision test set and

Two, the THD+N of the op amp is more than an order of magnitude (ie, ten times) better again, at 0.00003%.

So how does National Semiconductor manage to quote a value that cannot be measured?

Well, there is always a way! Although the THD+N cannot be measured directly, a simple set-up enables the ultra-low distortion to be measured indirectly. The circuit is as in Fig.1 and is taken directly from the National Semiconductor data sheet.

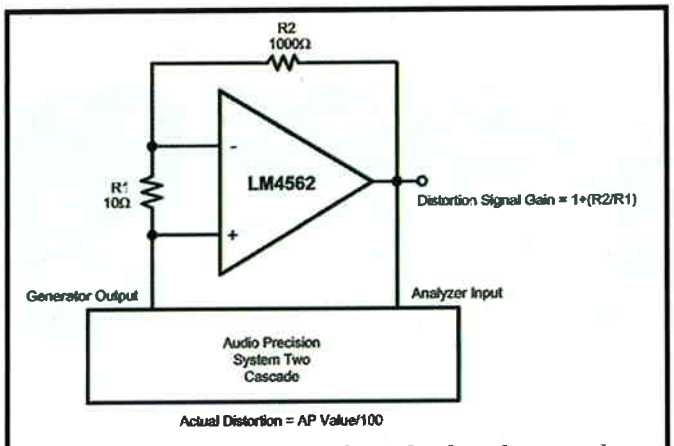

Fig. 1: The suggested circuit from the datasheet used to measure the ultra low distortion of the LM4562. R1 should be low, typically 10Ω.

The op amp is connected as a unity-gain buffer but with a low resistance R1 (around 10Ω) placed between the inverting and non-inverting inputs and a higher resistance R2 placed in the feedback loop.

The result is a closed loop gain of 1 but a noise gain of G=1+(R2/R1). This is because R1 and R2 effectively form a voltage divider.

This means that the error (ie, harmonic distortion) and noise signal is amplified by this factor and this allows the measurement to be made on currently available equipment!

Another way of looking at it is to regard the op amp as having its open loop gain reduced to a figure of 1 + (R2/R1) and this means that much less feedback is available to reduce the circuit non-linearity.

Either way, we decided to try this method to verify the typical ultra low THD+N figure given in the datasheet (0.00003%). This will vary according to the voltage of the test signal, its frequency and the impedance of the load, among other factors.

We connected the op amp as in Fig. 1. For R1 and R2 we used 10Ω and 1.2kΩ 5% resistors, which we measured using a digital multimeter to be 9.9Ω and 1202Ω respectively. You could use 1% resistors instead but since we were measuring the resistors with a multimeter, this would not make very much difference to the result.

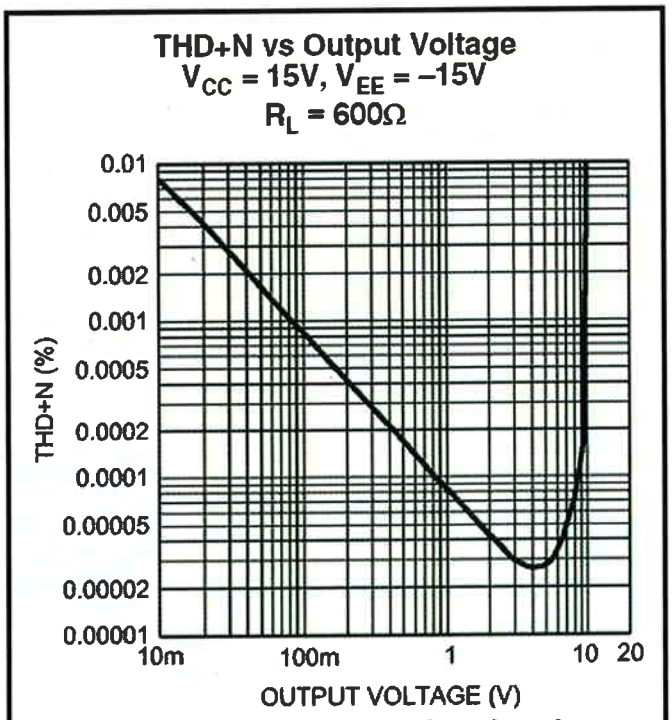

Fig. 2: graph of THD+N vs. output voltage from the LM4562 datasheet. The test load is 600Ω and the supply voltage is ±15V. At 3V RMS, the THD+N value is 0.00003%. Compare this with our measured value!

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ictor's LM4562 op amp

By Mauro Grassi

The distortion gain, using the formula 1+(R2/R1), was therefore

$$G=1+(1202/9.9)=122.41$$

A 1kHz 3V RMS test signal from the Audio Precision set is applied to pin 5 (the non-inverting input) and the output of the op amp at pin 7 is 3V (because the gain is unity).

We used a ±15V regulated supply that we measured to be within 0.06% of this value. However such small variations in the positive and negative rails as well as asymmetrical rails should not make any significant difference to the result since the LM4562 has a PSRR (power supply rejection ratio) of -120dB.

We selected a simulated load of 600Ω, to match the data sheet. We made sure to connect the unused op amp as a buffer with grounded non-inverting input, to prevent it from oscillating and contributing to the noise measurement via the common supply.

To measure the THD+N, we used the same technique as described on pages 28-30 of the June 2007 issue.

It involves using an oscilloscope with averaging to eliminate the noise on the distortion signal. This was found to be necessary because the breadboard version of the circuit in Fig.1 was quite prone to noise pickup.

So, if we let DV denote the RMS voltage of the residual distortion signal and AV denote the RMS voltage of its averaged version, we obtain the scaling factor F=AV/DV.

If we let MD denote the THD+N reading from the Audio Precision Test Set, which is made in the audio range 20Hz to 22kHz. Since the distortion gain is G, the true measurement for the THD+N should be:

$$F \times MD / G \ \%$$

Now the LeCroy WaveJet 324 scope we used cannot display the distortion and its averaged-out version simultaneously (as can the LeCroy WaveRunner) so we had to switch between the waveforms.

What we did was to take typical values as guides. Figs. 3 and 4 show screen grabs from the oscilloscope. Let's run through a typical calculation, with values as shown in Figs. 3 and 4.

From these screen grabs, we have AD=11.45mV and DV=59.3mV, being the RMS values of the averaged distortion signal and the normally sampled distortion signal, respectively. The ratio F is therefore F=AD/DV=0.1931.

Since the reading given by the Audio Precision Test Set was typically 0.013%, its true value (using the averaged residual distortion) was 0.1931 x 0.013 or .0025% Now since G was 122.41, the calculated value for the distortion is .0025 / G = 0.00002%, lower than the typical distortion given by the data sheet!

This technique of varying the distortion gain can be applied whenever the measurement to be made is too small for the available instrument. SC

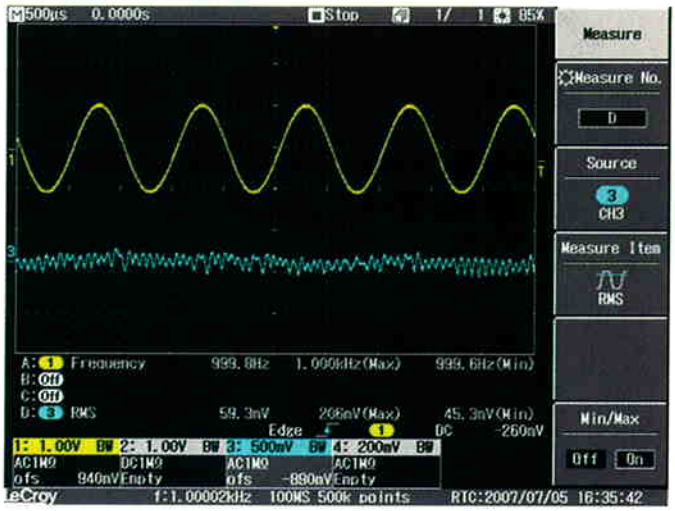


Fig. 3: Screen grab from of the Le Croy WaveJet showing the test signal in yellow, a 1kHz 3V RMS sine wave and the distortion signal at pin 7 of the LM4562 in cyan, showing the RMS value of DV=59.3mV.

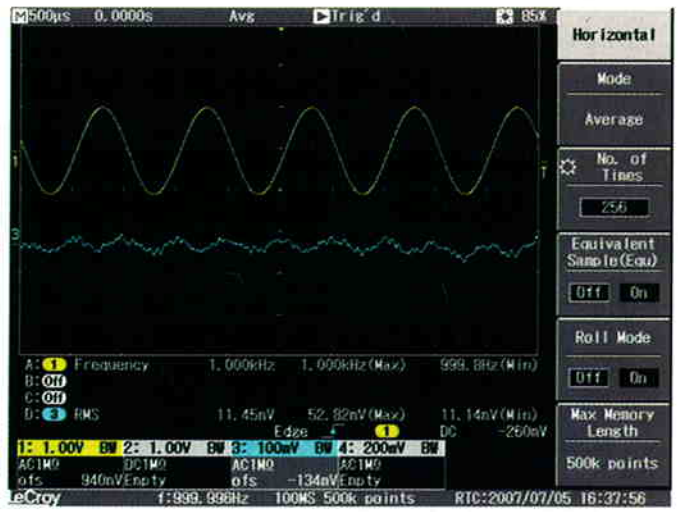


Fig. 4: Screenshot of the Le Croy WaveJet showing the test signal in yellow, a 1kHz 3V RMS sine wave and the averaged distortion signal at pin 7 of the LM4562 in cyan, showing an average RMS value of AD=11.45mV.

SERVICEMAN'S LOG

Serviceman Of The Overflow

Getting down on my hands and knees to service a dishwasher is not much fun but this was one those occasions when I had no choice. I'd much rather service TV sets any day, so let's start off with one of those.

Items Covered This Month

- Grundig Xedance 82 Flat
- AEG Favorite 675i dishwasher
- Sharp LC15AHIE LCD TV
- Telefunken SDX290H
- Philips 36PW9527/79R EM5A P/M

I thought I had an interesting fault when Mr Williams said his set would drop its colour during the advertisements but only on Channel 7. I could see all sorts of spin-offs to this. For years I had heard of boxes that would mute the sound for you during commercials – though I have never actually seen one. But if this set could turn its colour off, surely I could use the colour killer circuit to kill or even murder the sound during the ads!

Anyway, as luck would have it, Mr Williams didn't quite mention that there were other problems with the picture on Channel 7. Most were due to a fine herringbone patterning on the screen from co-channel RF interference. Mr Williams lived in a block of units in a poor reception area and he had a Grundig Xedance 82 Flat and had a Panasonic NV-FJ620 VCR connected to it. The VCR was connected to the aerial and then onto the TV. The RF output channel had been set to UHF channel 37.

On the very crowded UHF band on the North Shore of Sydney, this is not a good choice. There are several channels available and I reset this one to channel 69 and hoped for the best. It fixed up the patterning but only long-term use will confirm my remedy.

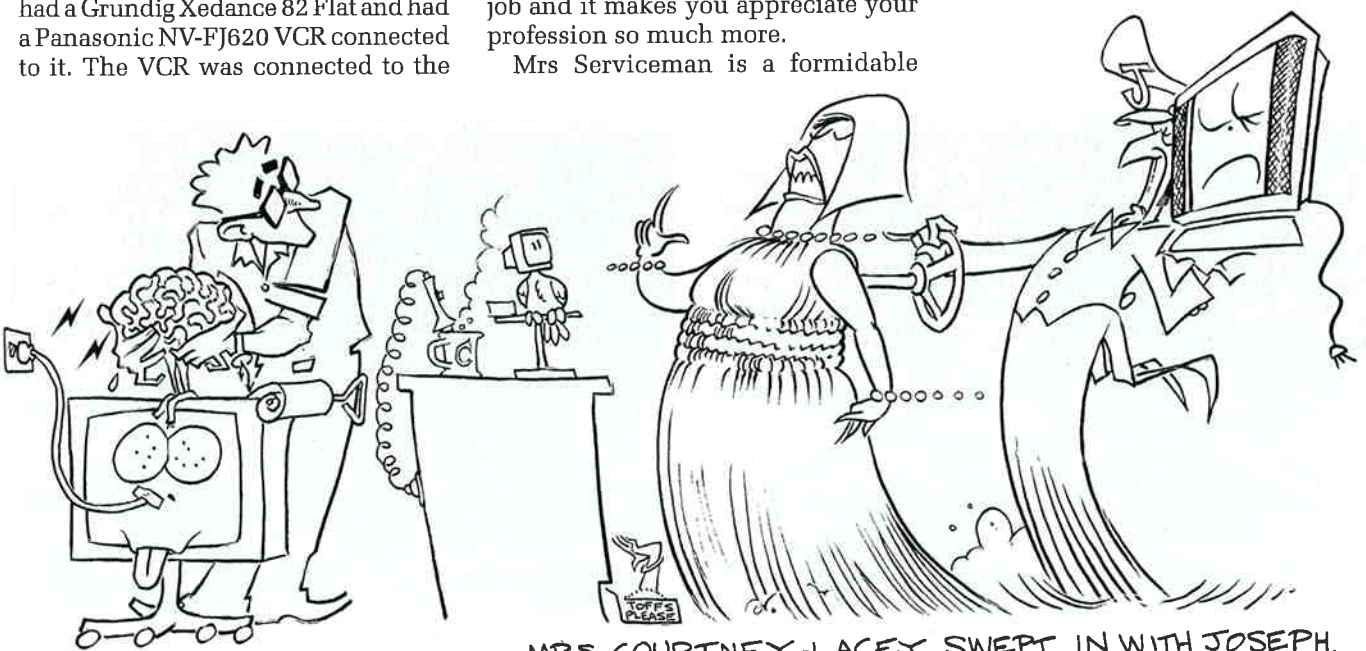
Serviceman of the overflow

Thank God, I am not a plumber or a white goods technician – though it would be nice to get their remuneration. The very thought of sewage or rotten food stuck in pipes is all too much for me.

It does, therefore, do one's soul good to be in their shoes even for just one job and it makes you appreciate your profession so much more.

Mrs Serviceman is a formidable person and when she asked me to fix our dishwasher you just knew there was going to be no negotiation in the matter. This was a direct missive from on high.

The offending machine was an AEG Favorite 675i dishwasher that was intermittently dead. Basically the machine would start working perfectly, then after a while you could hear a small clunk and then the whirring sound of a motor. It was at this point that it would stop its washing cycle and the touchpad keyboard would jam up. In fact, you could not do



MRS COURTNEY-LACEY SWEPT IN WITH JOSEPH, HER BUTLER-DRIVER WHO NATURALLY WAS CARRYING THE OFFENDING APPLIANCE.

anything for another 15 minutes or so when suddenly the motor would stop and the touchpad would start to work normally again. This cycle would be repeated every few days but the frequency was increasing.

I removed the covers and got down on my hands and knees and saw there was a tray underneath. In the centre of this tray there was a vertical shaft with a piece of foam on it. I worked out that this piece of foam would float on any water that was in the tray and as it rose, the foam would move up the shaft until it hit a microswitch at the top. This would then turn on a control solenoid and a pump motor which would empty the tray. This "flood control" was what was happening to this machine.

Not quite knowing what to expect, I concluded that this tray was for a safety overflow. But where was the water coming from? It certainly wasn't pouring in but I did notice from the discoloured melamine on the right-hand side that there was a water leak nearby.

But where from? Water is a little like electricity, with gravity being its driving force. The height above ground is equivalent to voltage and quantity to amps. So to find the water source you have to look upwards.

It took a long time to trace this but eventually I noticed a wet copper stain at the connection to the hot water tap. This disappeared into a loose flexible corrugated conduit which then went via the external solenoid into the machine and then dripped down the side of the cabinet into the tray.

So there was nothing wrong with the dishwasher. Tightening up the hose connector and refitting the conduit properly ensured the flood control was no longer necessary.

Mrs Serviceman should be pleased – I think I will ask for seconds of that lamb roast tonight.

There's a good chap

Mrs Courtney-Lacey swept in with Joseph, her butler/driver who naturally was carrying the offending appliance. She addressed me sharply and demanded I repair her thingummy bob as quickly as possible, if not immediately and then retired with her entourage, with the assertive parting shot – "Now there's a good chap".

Well a command like that has to be obeyed – it was almost, well, like Mrs Serviceman talking to me. Maybe they know each other!

The set was a Sharp LC15AHIE LCD TV and the problem was that it intermittently wouldn't come on or stay on and it flickered. My first step was to engage the service test mode by pressing the appropriate buttons while switching the power on. This gave a letter "K" in the top lefthand corner of the blue screen. Pressing "Volume-" and "Channel-" together places the set into the adjust mode and it then displayed "Error..5" on the screen. Pressing "Volume-" then reset the error count from 5 to 0. That done, I turned the set off and on and it then worked perfectly every time.

This is all part of the TV's protection system. If you try to start and stop this set rapidly more than five times in succession, it goes into protect mode and the error buffer has to be reset. I soak-tested this set for a long time until I was sure that this was the whole problem. So why did it do this?

This required a phone call to our lady who told me that it was actually the set they used on their yacht. After a bit of probing and a chat with Joseph, I found out that they used an inverter to run it.

I then had the temerity to advise them that this set would not work satisfactorily with this arrangement. The inverter waveform had too many spikes that would set off the inbuilt error counter.

Mrs Courtney-Lacey was not amused but agreed finally to use it up at the house and not on the yacht. She was lucky in this case because these spikes can often destroy the power supply and as I described last month the repair

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kit requires a lot of work to install. She must have had some inkling of what I said because she had already tried three other Sharp LCD sets which had all had the same problem and so accepted my reasoning.

A dreaded old set

A blast from the past arrived on my bench. It was a Telefunken SDX290H with no vertical deflection. This set is a bit of an enigma because it doesn't really fit into any category. Fundamentally, it is a French-made Thomson ICC7 chassis but actually is an ICC7000 about 15 years old. It was a very sophisticated set for its time and was also very reliable and performed well. But (there is always a but) it is a beast to service. To top it off, there is no service manual available for this specific model.

The set has multiple short leads to a chassis that has components on both sides which are all closely packed. If you were contemplating taking on such an ancient set, I would advise you strongly to draw a diagram of where all the plugs go. Most of the faults are well known and you can use an ICC7 circuit with reasonable confidence. I suspected the vertical output IC IF01 TDA8178/F was faulty, as the 15Ω fusible resistor R11 was open-circuit.

Fitting new parts was disappointing, as it made no difference to the symptoms. The common problems for this set are the supply rails and the fusible resistors, especially additional components that were added onto the ICC7000 chassis rather than the ICC7; eg, the 4.7Ω resistor fitted instead of link J238.

Anyway I found nothing wrong with most of the usual suspects, so I started measuring the voltages on each of the seven pins of the IC. The only voltage that was incorrect was the output voltage to the deflection yoke which was high.

Now as any keen audiophile would know, an amplifier's DC output voltage is normally half that of the voltage supply rails. Seeing that everything else was OK, I deduced that it had to be the IC. That was when I noticed that the IC had an extra suffix. It was actually a TDA8178/FS (or equivalent STV9379F) and this requires modification for the internal reference voltage.

An additional 3.9kΩ and 2.7V zener needs to be fitted from the 65V rail (for the STV9379F the zener would have to be 2.1V, which is a big ask as they are hard to obtain). This mod restored the vertical deflection but not completely. The electros surrounding the packed IC needed to be changed as well.

Fixing a heavy Philips

Peter Williams specifically asked for a house service call because his TV weighed a tonne and was upstairs. He had a Philips 36PW9527/79R wide screen CRT TV employing an EM5A P/M chassis. The weight was all in the 86cm picture tube. He complained of poor focus but by the time I arrived, there was no picture. Removing the back was a bit of a drama until I remembered you have to remove the fancy trim on the top rear of the cabinet.

I switched the set on and noticed it took a very long time for the LED to change from red to yellow to green but I had been pre-warned about this as this set is fitted with lots of protection circuitry. By now there was no picture at all and I thought this was going to be easy because the CRT filaments weren't coming on.

Expecting just dry joints in the CRT filament circuit from the line output transformer, I had a quick look at the service manual to follow its route when I noticed a lot of references to PCB I DAF (Dynamic Active Focus – both horizontal and vertical). The filament voltage is also connected to this board via transformer 5810 and FET 7810, along with the focus – both related to the symptoms this set was suffering from.

Moving the CRT board F brought the picture tube filaments back on but there was still no sign of a raster. The RGB amplifier ICs on the CRT board are too sensitive to survive a quick short to ground on one of the cathodes of the CRT to see if there is a picture.

Measuring various voltages, I established we had EHT but no screen (G2) voltage. The focus was just too hard to measure. I measured the emission of the picture tube to be OK. With the above info in mind, I took a stab and diagnosed that the twin focus and screen control assembly part of the flyback must be faulty but to be sure, I decided to confirm my diagnosis and fit this chassis into another similar set I had in the workshop.

I ordered a new transformer but was amazed to find the supplied replacement was quite a lot different from the original. However, I duly replaced it along with C2435 (9.1nF, 2kV) across the line output transistor for good measure and resoldered the vertical output IC just in case.

I took the chassis back, reinstalled it, crossed my fingers and switched on. When I heard the sound come on,

Something old, something new – a 1957 Healing B&W TV set working from a digital set-top box!

I decided now was the time to turn the screen control (G2) up and look for a picture.

It was a relief to see the picture come on, even if it was out of focus. A few more judicious twiddles of the dynamic and static focus controls and I get a pretty good picture – but – quelle horreur!! The picture was upside down and the wrong way round!!

For such a drastic turn of events I must have done something really STUPID – I mean, even more than normal!

Well, I examined all the plugs and sockets to the deflection yoke and really you couldn't actually plug them in the wrong way around. They were all keyed, colour coded and non-interchangeable. The panic level was rising within me but I kept my head and tried phoning colleagues to see if this had ever happened to them – which of course it hadn't. It only helped to reinforce their opinion of me that it was time I was put out to pasture.

In the end, there was nothing for it but to swap the leads over to the yoke.

I started with the vertical deflection and cut and resoldered them the opposite way round. I thought it would be a good idea to check it before going on to the horizontal deflection yoke.

To my amazement not only did this fix the upside down picture but also the left to right scan! It was now normal. Please don't try to explain the logic to me; I don't think I could handle it.

Fortunately, after the necessary adjustments this fixed the problem.

The penny didn't drop until I got back to the workshop and found on the floor a small extension lead which fitted the vertical deflection plug and socket. It was this that changed its polarity.

Interesting picture

Finally, at the top of this column is an interesting photo from last month's round up. It shows a 1957 Healing TV set working from a digital set-top box! SC

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Adaptive Turbo Timer

By JOHN CLARKE

If your car's turbocharger has just been running, it is vital to allow the engine to idle for a few minutes before switching off. This Adaptive Turbo Timer will do the job automatically. It only operates when necessary and sets the idle time according to how hard you've driving.

FOR MOST DRIVERS of turbo cars, having to leave the engine idling for a short period before switching off is often not particularly practical. Alternatively, they may simply forget to do it.

Another problem is that in many cases, it is not really necessary. Your trip may have been rather slow and the turbo did not run. Or with brisk driving, the turbo may have been running but not in the last few minutes. At other times though, when the turbo has just been in use, the engine should be idled to allow cool-down.

Why do car manufacturers recommend this idle period? It is all to do with prolonging the life of the turbocharger and particularly, its bearings. Switching off the engine immediately after turbo operation means that the turbo will still be spinning, as it runs at very high speeds. This also means that the bearings will then run without any fresh circulating oil from the engine. Any residual bearing oil will overheat and burn or tarnish due to the very high turbo temperatures.

If this happens repeatedly, the result will be premature bearing wear. By contrast, idling the engine for a while before switching off will maintain the lubrication until the turbo cools.

Whether to idle or just stop the engine when you park is a decision you must make every time, unless you install a turbo timer. However, most turbo timers will always idle the engine before switching it off, regardless of whether this is required or not. This is the case with the Turbo Timer published in the November 1998 issue of SILICON CHIP.

Our new Adaptive Turbo Timer is different as it makes the decision as to whether to provide the cool-down period and if so, for how long. Its decisions are based on the vehicle's recent driving history. If the turbo has not been used for the last 15 minutes, for example, no cool-down period will be provided. On the other hand, if the turbo has been active in the last few minutes, the engine will be idled for proper turbo cool-down.

How does it know?

So how does the Adaptive Turbo Timer monitor recent driving history and alter the cool-down time accord-

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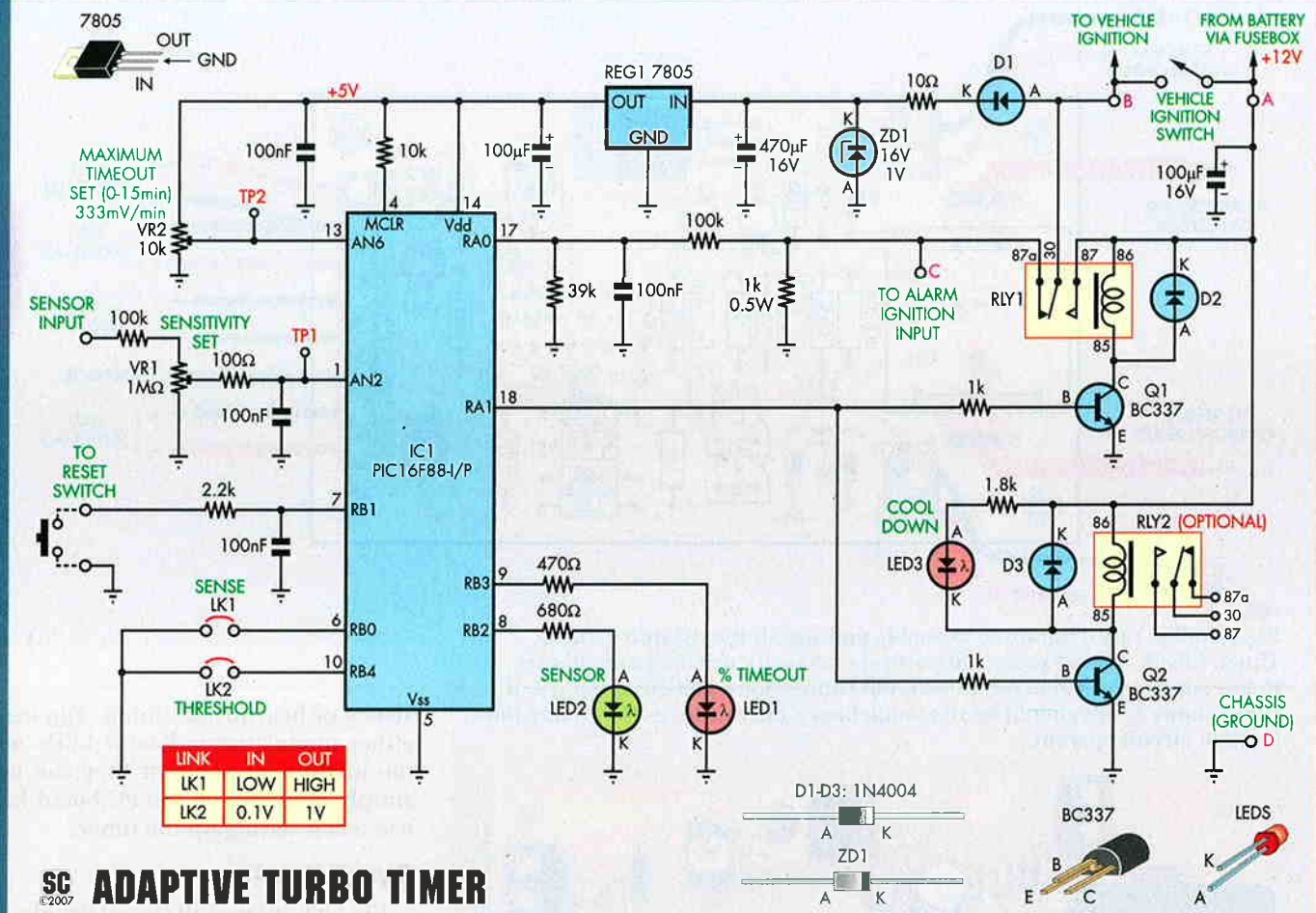

SC ADAPTIVE TURBO TIMER

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Fig.1: the circuit is based on microcontroller IC1 which monitors the sensor signal at its AN2 input. IC1 determines the cool-down period and controls the car's ignition circuit via transistor Q1 and relay RLY1. Relay RLY2 is used to bypass an engine immobiliser (if fitted) during the cool-down period.

Main Features

- Automatic operation
- Cool-down period adapts to the turbo boost usage
- Adjustable maximum cool-down period
- Reset switch
- LED indication of current cool-down timeout period
- LED indication during cool-down
- LED indication of sensor level
- Sensor inversion selection

ingly? It does this by monitoring an engine sensor that is load dependent. Typically, this will be an airflow sensor, a Manifold Absolute Pressure (MAP) sensor, an oxygen sensor, a throttle position sensor or a temperature sensor. Only one sensor is needed to provide this engine information.

In operation, the Adaptive Turbo Timer monitors the sensor's signal over a period of time and tallies up the amount of time the signal is above and below a preset value. To do this it samples the sensor signal 256 times over this tally period. The tally period is a minimum of five minutes but can be up to 15 minutes, depending on the maximum cool-down timer setting. The sensor signal is sampled every 1.17 seconds for a tally period of five minutes and once every 3.52 seconds if the tally period is set to 15 minutes.

Note that the sensor is continuously monitored but only the data within the tally period is relevant and older data is continually discarded. A sensor LED indicates whenever the preset value has been exceeded. The maximum cool-down period can be set anywhere between 0-15 minutes.

The amount of time the sensor signal is above the preset value compared to the time under the preset value can be represented as a percentage. It is this percentage which largely determines the cool-down period.

The monitored signal is also weighted according to how recent the data is. This means that the most recent quarter of the tally period has a greater effect on the timer cool-down period than earlier quarters.

The actual weighting is such that the most recent quarter has four times more effect than the first quarter. Similarly, the second most recent quarter has three times more effect and the third most recent quarter has twice the effect of the first quarter.

The resultant cool-down period is indicated by a LED that has a brightness level that varies according to the percentage of full timeout period. So if the timeout is 100% of the setting, then the LED will be fully glowing.

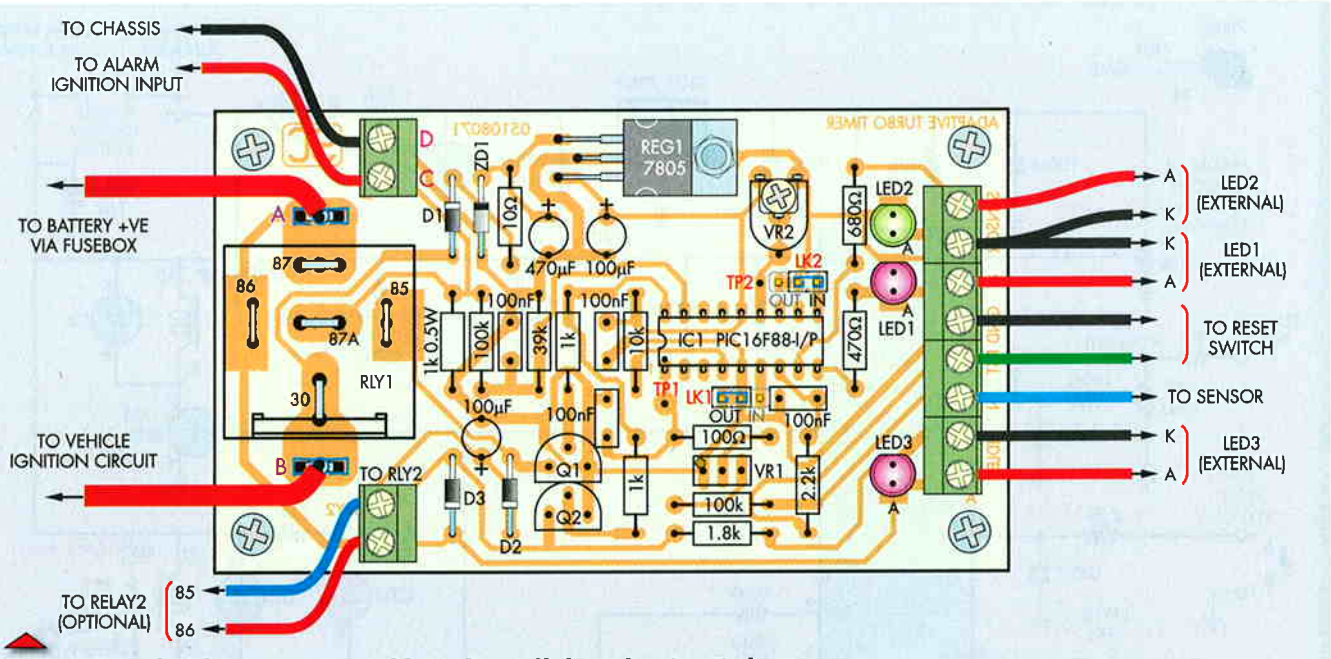
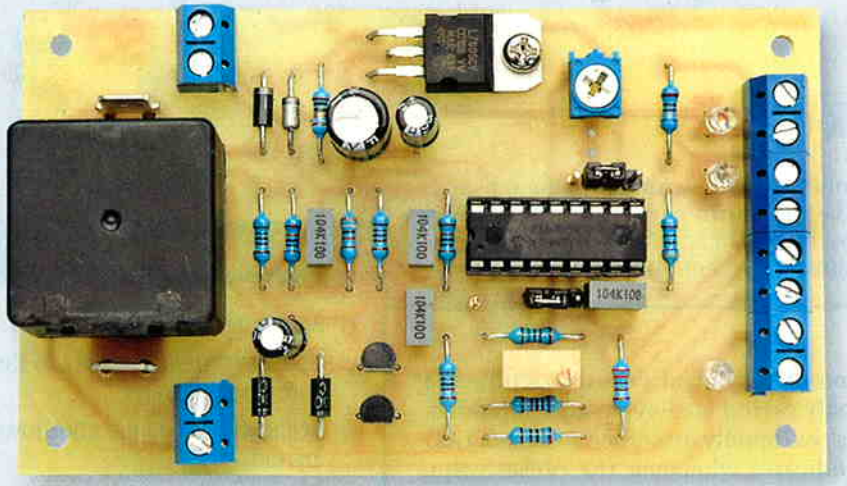


Fig.2: follow this diagram to assemble and install the Adaptive Turbo Timer. Check that all polarised parts are correctly oriented and be sure to use automotive cable for all external connections. Note that the A & B connections at left should be run using heavy-duty cable as they carry the ignition circuit current.



This is the completed unit, ready for installation. You can either mount the LEDs on the PC board and use them during the setting-up procedure or you can mount them on the dash and connect them via flying leads.

Lower percentages will have the LED glow at a lower brightness.

When driving, this LED will be seen to vary in brightness according to the amount of time the turbocharger has run. It gives a good indication of just how much time the cool-down period will be when the engine is switched off. An Idle LED also lights during the cool-down period.

Using it

The Adaptive Turbo Timer is easy to use. Just drive the car and when you switch off the ignition, the Adaptive Turbo Timer will either allow the engine to switch off or run it for a further short period, depending on the amount of recent turbo use. However, if you wish, you can override the cool-down period at any time and switch off the engine at any time by pressing a reset switch.

As shown in the photos, a small PC board accommodates all the main parts for the Adaptive Turbo Timer. This board can be mounted inside a plastic box or it can be wrapped in a sleeve of heatshrink tubing. You can either mount the indicator LEDs on the instrument panel or they can be simply mounted on the PC board for use when setting up the timer.

Circuit details

Fig.1 shows the full circuit details of the Adaptive Turbo Timer. It's based on a PIC16F88-I/P microcontroller (IC1) and this monitors the engine sensor signal at its AN2 input (pin 1). IC1 also monitors the ignition voltage at its RA0 input (pin 17) and checks when the ignition is switched off.

The cool-down period is enabled by relay RLY1 which is connected in parallel with the cars's ignition switch. Pushbutton switch PB1 is connected to IC1's RB1 (pin 7) input and can be used to cancel the cool-down period and switch off the engine.

The car's ignition switch is monitored by RA0 (pin 17) via the normally closed contacts of relay RLY1 (30 & 87a). The input voltage to pin 17 is fed via an RC filter (100kΩ resistor and 100nF capacitor) to prevent any false triggering by transient voltage spikes. The 39kΩ resistor to ground attenuates the input voltage and is included so that the ignition voltage required to trigger the RA0 input is around 2V. This ensures faster and more reliable detection of the ignition switch off.

Normally, when the ignition is switched off, pin 17 is pulled low via a 1kΩ resistor. However, when the igni-

tion is switched off and the micro has calculated that a cool-down period is warranted, its RA1 output goes high and switches on NPN transistors Q1 & Q2. Q1 drives relay RLY1 and this closes the normally open contacts (30 & 87) to reconnect the ignition supply to the engine.

This happens so quickly that there is no faltering in the engine.

At the end of the cool-down period, the RA1 output goes low and switches off the relay (thus turning off the engine). Diode D2 is connected across the relay coil to quench the spike voltage that occurs when the relay's coil current is switched off.

Q2 and the optional relay RLY2 is provided to bypass any after-market engine immobiliser that may have been installed until after the cool-down period. Q2 also drives LED3 to indicate that the Turbo Timer is providing cool-down time. LED3 goes off after the cool-down period.

Note that if an alarm is fitted, it must have its ignition input signal taken from the 87a contact of RLY1. If this is not done, the alarm is liable to sound during the cool-down period.

Cool-down setting

Trimpot VR2 sets the cool-down period. Its wiper is connected to the AN6 input of IC1 (pin 13). VR2 provides a voltage between 0-5V and this is converted to a digital value within IC1. The cool-down period is zero when VR2 is fully anticlockwise and 15 minutes when it is fully clockwise.

Test point TP2 is a convenient point to measure the setting of trimpot VR2. Table 1 shows the timeout voltages for several settings of VR2. For example, a setting of 333mV will provide a 1-minute cool-down period, a 1V setting will provide three minutes and a 5V setting will provide 15 minutes.

The cool-down setting value is checked by IC1 whenever power is applied. This means that if you change the setting of VR2, the timing period will only change after power has been switched off and on again.

Engine sensor

As mentioned above, the AN2 input (pin 1) monitors the engine sensor signal. The sensor input has a relatively high input impedance, due to the 100kΩ series resistor and 1MΩ trimpot VR1. VR1 attenuates the input signal level, while the 100nF capacitor provides a degree of filtering.

In operation, the AN2 input signal is converted to a digital value within IC1 and compared to a 1V level. LED2 lights when ever the signal at AN2 is above or below 1V, depending on the "voltage sense" setting provided by link LK1.

Alternatively, the signal threshold can be set to 100mV when link LK2 is inserted. This lower threshold is more suitable for the signal from an oxygen sensor.

With LK1 out of circuit, the RB0 input (pin 6) is held high via an internal pull-up resistor. When LK1 is installed, it pulls the input to ground. **This link is only installed if the engine sensor's output voltage decreases with engine load.**

As stated earlier, the brightness of LED1 gives an indication of the cool-down period. It is driven using a pulse-width modulated (PWM) signal from pin 9 via a 470Ω current-limiting resistor. When the cool-down percentage is 100%, pin 9 outputs a nominal 5V and gives maximum LED brightness. Lower cool-down settings result in a PWM signal with reduced duty cycle and therefore reduced brightness from LED1.

Input RB1 (pin 7) is normally tied to +5V via an internal pull-up resistor. When reset switch PB1 is closed, pin 7 is pulled close to 0V and this is detected by IC1 as a switch closure.

IC1 operates from an internal 8MHz oscillator. This sets the operating rate of the micro and the clocking for the timers that tally the sensor input signal and provide the cool-down period.

Power for the circuit comes from the switched side of the ignition switch and so power is applied only when the ignition is on or while relay RLY1 is closed (ie, during the cool-down period). Diode D1 provides reverse polarity protection, while a 10Ω resistor and zener diode ZD1 are used to clamp

Warning!

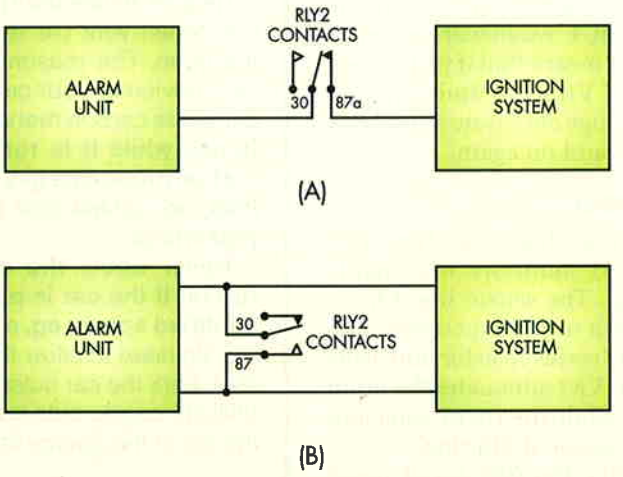
Be sure to use the Turbo Timer only when your car is parked in the open. The reason for this is fairly obvious – **your car's engine exhausts carbon monoxide (CO) fumes while it is running and carbon monoxide gas is colourless, odourless and extremely poisonous.**

Never allow the engine to run on if the car is parked in a confined space; eg, a garage. If you do need to allow the turbo to cool, park the car outside instead until the engine cuts out and park the car in the garage later on.

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	39kΩ	orange white orange brown	orange white black red brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	1	2.2kΩ	red red red brown	red red black brown brown
❑	1	1.8kΩ	brown grey red brown	brown grey black brown brown
❑	2	1kΩ	brown black red brown	brown black black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	1	680Ω	blue grey brown brown	blue grey black black brown
❑	1	470Ω	yellow violet brown brown	yellow violet black black brown
❑	1	100Ω	brown black brown brown	brown black black black brown
❑	1	10Ω	brown black black brown	brown black black gold brown

Working With A Burglar Alarm



If an alarm is fitted to your car, this has been taken into account in the design of the Adaptive Turbo Timer. A second relay – RLY2 – can be used to bypass the alarm system's engine immobiliser. This relay is connected to the bottom two terminals on the PC board.

Where your alarm system disables the ignition by shorting it out, connect the relay between the alarm immobiliser output and the ignition system using the 30 and 87a contacts as shown at (A). Alternatively, if the alarm system open circuits the ignition, use the 30 and 87 contacts to reconnect the ignition as shown at (B).

In addition, if the alarm requires an ignition signal, use the "To Alarm Ignition Input" connection on the Turbo Timer.

voltage transients. A 470µF capacitor then filters the supply after which it is fed to regulator REG1.

REG1 produces a +5V rail to power the microcontroller, while the relays are powered by the vehicle's battery. The 100µF capacitor at REG1's output provides extra decoupling.

Construction

The Adaptive Turbo Timer is built on a PC board coded 05108071 and measuring 107 x 61mm. If you don't like the idea of fitting it with a heat-shrink sleeve, it can be housed in a standard plastic case measuring 130 x 68 x 44mm – the board simple clips into the integral side slots.

Most of the external connections to the vehicle are made via PC-mounted screw terminal blocks. The exceptions here are the two external connections to the relay, which are run via PC-mount spade connectors (necessary for the heavier current).

Begin construction by checking the PC board for any defects (eg, shorted or open circuit tracks) and for the correct hole sizes. The holes for the screw terminal blocks will need to be larger than the 0.9mm holes for the other components – ie, about 1.2mm. Relay RLY1 requires slotted holes to accept its spade terminals.

Fig.2 shows the parts layout on the board. Start the assembly by installing the resistors first, taking care to place each in its correct place. Table 1 shows the colour codes but you should also use a digital multimeter to check each resistor before inserting into the PC board.

The diodes and the IC socket can go in next, taking care to orientate each with the correct polarity. The capacitors can then go in but note that the electrolytic types must be oriented as shown on Fig.2.

Next on the list are the two transistors which can now be soldered into place. LEDs 1-3 can either be mounted on the PC board or mounted externally (eg, on the dash). Note that the LED mounting pads are also brought out to the screw terminal blocks, to make external mounting easy.

If you are mounting the LEDs on the PC board, take care to orient them with the anode (longer lead) as shown on Fig.2. LEDs 1 & 3 are red while LED2 is green.

Trimpots VR1 & VR2 can now be installed, followed by the two 3-way link headers for LK1 and LK2. REG1 is mounted horizontally on the PC board with its leads bent over by 90° to insert into the allocated holes. The regulator's tab is then secured to the PC board using an M3 screw and nut, after which the leads can be soldered.

Don't solder the regulator's leads before bolting it down, as this may strain the soldered joints as the nut is tightened.

Once these parts are in, install the two independent 2-way PC-mount screw terminals. The 8-way block at the righthand edge can then be installed. It's made up using six of the 2-way screw terminals. They connect by sliding the dovetail joints together before installing the assembly on the PC board.

Finally, install the relay and the two spade connector terminals which are soldered directly to the PC board. Note that the relay's mounting tab will have to be cut off before it is installed.

Testing

Now for the smoke test. Initially, leave IC1 out of its socket and connect a wire so that you can open and close the circuit between spade terminals A and B. This simulates the car's ignition switch.

Next, apply +12V to the A terminal and 0V to the ground or chassis screw terminal. That done, use a multimeter to check the voltage between pins 14 & 5 of IC1's socket – you should get a reading of 5V (anywhere between 4.85V and 5.15V is OK).

If this checks out OK, switch off and install IC1 in its socket. Be sure to orient the IC correctly – the notched end goes to the left.

Adjustments

Initially, set VR2 to its mid position. This will provide a nominal 2.5V at TP2 for a 7.5-minute timeout. Jumper pins LK1 and LK2 should be fitted to their OUT positions.

Apply power (+12V) again to the A terminal and close the connection between the A and B terminals (ie, connect A & B together). That done, you need to simulate a sensor signal by connecting a wire between the sensor input terminal and the A input.

Specifications

Cool-down idle period: up to 15 minutes

Recent driving history monitoring: 5 minutes or equal to cool-down setting.

Recent driving history weighting: fourth ¼-period weighted by a factor of 4; third ¼-period weighted by 3; second ¼-period weighted by 2; first ¼-period weighted by 1.

Sensor input adjustment range: 1.1-15V or 0.11-1.5V, selected with LK2

Sensor input threshold: 1V or 0.1V, selected with LK2

Sensor input sense: positive or negative, selected with LK1

Sensor input impedance: 1.1MΩ

Next, adjust VR1 so that the voltage at TP1 is just over 1V and check that LED2 (the sensor LED) lights. If you now disconnect the sensor input from the A terminal, the sensor light will go out after a maximum of 1.8 seconds. Reconnecting the sensor input to the A terminal again should then turn the LED on again after a maximum of 1.8 seconds.

You should now see LED1 (the "percentage timeout" LED) begin to glow and increase in brightness during the period that LED2 is lit. It will stop increasing in brightness when the sensor input is disconnected from the A terminal and LED2 goes out. (Note: the percentage timeout LED shows the current percentage of the cool-down timeout set by VR2).

If you now disconnect the link between the A and B terminals, relay RLY1 should close (indicated by a click as the contacts close) and LED3 should light. The cool-down period will be up to 7.5 minutes but less if LED1 is not glowing at full brightness.

LED1 will now begin to decrease in brightness until it extinguishes. At the end of the cool-down period, the relay will then switch off and LED3 will also extinguish.

Installation

When installing the Adaptive Turbo Timer in your car you will need to select a suitable sensor that changes its output with engine load. There are several sensors that can be used and these are listed below, in order of preference:

(1) Airflow Meter: this type of sensor provides a good indication of engine load. High airflow means that the engine is being driven hard and the turbocharger would be expected to be applying boost.

Airflow sensors generally have a rising voltage with airflow that ranges from about 0.5V at idle through to about 4.5V at high engine loads. Note that some airflow sensors do not change in voltage but provide a change in frequency instead. A frequency output signal is unsuitable for use with this circuit.

You can monitor the airflow signal by connecting a digital multimeter to its output and then driving the car. The voltage should change with engine load. If it doesn't, you may be measuring the wrong wire or the output may be a varying frequency.

(2) MAP (Manifold Absolute Pressure) sensor: this measures the air pressure at the manifold or at the air intake, the output voltage increasing with rising pressure – ie, with increasing engine load. MAP sensors generally cover the range of 0.5-4.5V. With turbo boost, the MAP sensor should provide higher output voltages than those derived without boost.

(3) Oxygen Sensor oxygen sensors measure the air/fuel mixture by detecting the amount of oxygen present in the burnt fuel. Generally they produce a signal range of 0-1V, with the higher voltage meaning a rich mixture.

For many cars, the engine runs rich when accelerating and so the signal could be used to indicate when the engine is being driven hard. However, some cars do not run rich under acceleration and remain running with stoichiometric mixture instead. In this case, the sensor would be unsuitable because its output essentially does not change.

You can check the oxygen sensor output during driving by connecting a digital multimeter to it.

Parts List

1 PC board, code 05108071, 107 x 61mm
1 UB3 plastic case, 130 x 68 x 44mm (optional – see text)
1 SPDT 12V horn relay (RLY1), Jaycar Cat. SY-4070
1 SPDT 12V horn relay (RLY2), Jaycar Cat. SY-4070 (optional)
1 momentary closed pushbutton switch (PB1)
6 2-way PC-mount screw terminals with 5.08mm pin spacing
1 18-pin DIP socket for IC1
2 3-way pin headers
2 jumper plugs
2 6.3mm insulated female spade connectors
2 6.3mm male PC-mount spade connectors
1 M3 x 10mm screw
1 M3 nut
2 PC stakes
1 2m length red automotive wire
1 2m length yellow automotive wire
1 2m length black automotive wire

Trimpots

1 1MΩ top adjust multi-turn trimpot (VR1)
1 10kΩ horizontal mount trimpot (code 103) (VR2))

Semiconductors

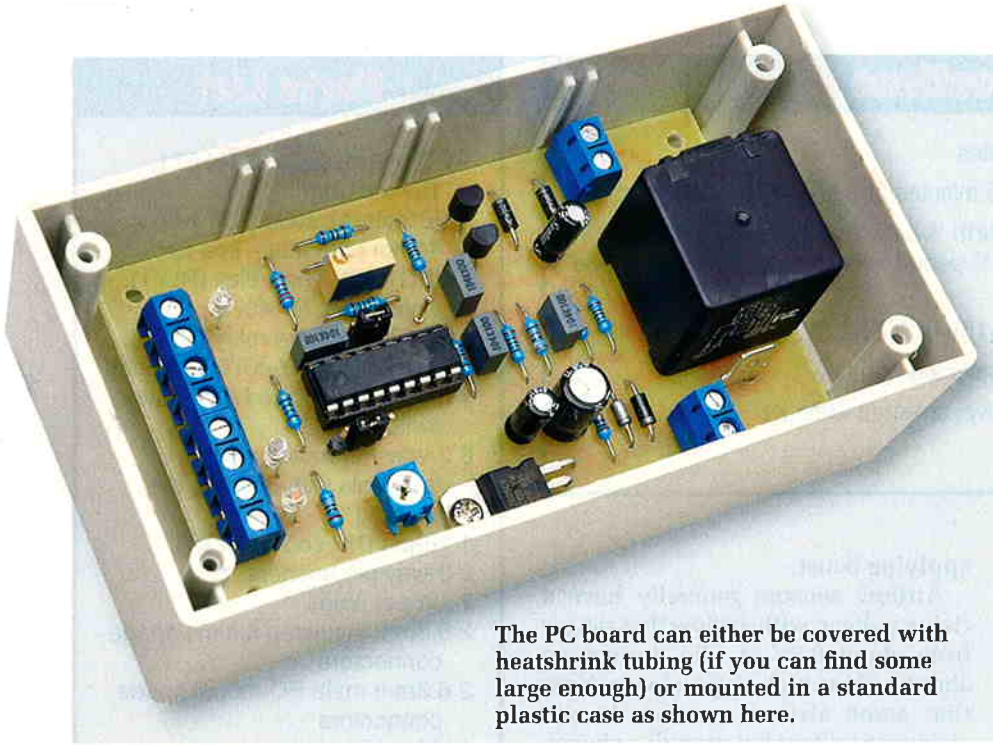
1 PIC16F88-I/P microcontroller programmed with Adaptive Turbo Timer.hex (IC1)
2 BC337 NPN transistors (Q1, Q2)
1 7805 5V 1A 3-terminal regulator (REG1)
1 16V 1W zener diode (ZD1)
3 1N4004 1A diodes (D1-D3)
2 3mm red LEDs (LED1, LED3)
1 3mm green LED (LED2)

Capacitors

1 470µF 16V PC electrolytic
2 100µF 16V PC electrolytic
4 100nF MKT metallised polyester (code 104 or 100n)

Resistors (0.25W 1%)

2 100kΩ
1 39kΩ
1 10kΩ
1 2.2kΩ
1 1.8kΩ
2 1kΩ
1 1kΩ 0.5W
1 680Ω
1 470Ω
1 100Ω
1 10Ω



The PC board can either be covered with heatshrink tubing (if you can find some large enough) or mounted in a standard plastic case as shown here.

(4) Throttle position sensor: although not ideal, the throttle position sensor could also be used as it changes its output voltage when the throttle is pressed.

(5) Temperature Sensor: older cars may not have any of the abovementioned sensors and so you could connect to the coolant temperature sensor instead. This will generally produce a high voltage when cold and reach a low voltage when the coolant is hot.

Making the connection

When making a connection to these sensors it is not necessary to cut the wire – just tap into it instead. The connection can be made at the ECU (Engine Control Unit) or at the sensor itself. The Adaptive Turbo Timer's sensor input has a high impedance so it will not affect the operation of sensor it is connected to or cause problems with driveability.

Once you have found a suitable engine sensor, the remaining connections to the Adaptive Turbo Timer can be made. The A and B connections need to be made using heavy-duty wire as they carry the ignition circuit current. It helps here if you can access the back of the ignition switch.

Using a multimeter, locate a wire going to the ignition switch that always has battery voltage on it. That done, turn the ignition key to the ON position and find the wire that now has battery voltage on it but reverts to 0V when the key is turned off.

Note that when making connections, you should disconnect the car's battery. This will mean that you will lose the settings in your car's radio so be sure you have the security password to enable you to reset it when the battery is reconnected.

The Reset pushbutton should be mounted in a convenient position (ie, within reach) on the dashboard. As mentioned, the indicator LEDs can also be dashboard mounted, so that the cool-down period and the time remaining can be readily monitored.

Setting up

You need to have access to the PC board in order to carry out the setting-up procedure. That's because you have to adjust the trimpots and be able monitor the LEDs (if they are on the PC board).

Initially, you can set VR2 to the maximum cool-down period that you will need. Some guidance for this should be in your car's user manual. It's generally in the region of 4-7 minutes but some high-performance cars may need longer.

The next step requires adjustments to be made while the car is driven and so a second person is required to assist with this. Get someone to drive the car while you monitor the sensor LED (LED2). Adjust VR1 so that the LED lights when the car accelerates quickly and the turbo boost comes on.

Table 2

Cool-Down Period	VR2 Setting (Voltage At TP2)
15 minutes	5V
14 minutes	4.67V
13 minutes	4.33V
12 minutes	4V
11 minutes	3.57V
10 minutes	3.33V
9 minutes	3V
8 minutes	2.67V
7 minutes	2.33V
6 minutes	2V
5 minutes	1.67V
4 minutes	1.33V
3.5 minutes	1.17V
3 minutes	1V
2.5 minutes	0.83V
2 minutes	0.67V
1.5 minutes	0.5V
1 minutes	0.33V
30 seconds	0.17V
15 seconds	0.08V

If you have connected the unit to the oxygen sensor, then LK2 may need to be placed in the "in" position so that the threshold voltage for sensing is 100mV (0.1V) instead of 1V. Also, for some sensors, the sense may be incorrect and the LED may light for light engine loads and turn off at high engine loads. In that case, place LK1 in the "IN" position to reverse the sensor sense.

You will find that the percentage LED is invaluable for showing the amount of time the Adaptive Turbo Timer is expected to run. You can adjust the maximum cool-down period with VR2 to get the correct cool-down period with various driving styles.

Note that any change with VR2 will not come into effect until the Turbo Timer is switched off and on again.

When the unit is correctly adjusted, there should be no cool-down period if the turbocharger has not been used (ie, with normal driving). Cool-down should also not occur if several minutes have elapsed since the turbocharger was last used. Conversely, the cool-down timer should operate after hard driving. SC

Add extra bass to your system with this

Subwoofer Controller

Adding a subwoofer to your home theatre or hifi system is the easiest way to extend the bass response. A relatively small speaker system driven by a big amplifier can give heaps of bass while not taking up a lot of space. This new Subwoofer Controller has all the features you could want, including low and high pass filters, parametric equaliser and auto-turn on.

The previous (and only) subwoofer controller described in SILICON CHIP was featured in the December 1995 issue.

Since then we have had quite a lot of input from readers and this completely new design is our response to our readers' comprehensive wish list.

Adding a subwoofer to a home theatre or hifi system can achieve a dramatic improvement in listening enjoyment, by extending the response of the system down into the low bass frequencies. But this improvement can only be fully realised if various basic conditions are met:

1. The crossover between your main system speakers and the subwoofer is smooth, with no obvious peak or dip in overall frequency response during the transition; otherwise the system will sound either boomy or weak in bass.
2. The subwoofer level is correctly balanced or matched with the level from the rest of the system speakers.
3. The response of the subwoofer itself is smooth (ie, without pronounced peaks or dips) over its operating frequency range.
4. Very low (subsonic) frequencies

By JIM ROWE

← 48

Subwoofer Controller Specifications

Input impedance:	Line level and LFE signal inputs 47kΩ Speaker line inputs 10kΩ with an 11:1 mixing divider
Gain:	-8dB to +8dB, variable
Low pass filter:	Corner frequency variable between 41Hz and 200Hz 12dB/octave rolloff slope
Parametric equaliser:	Centre frequency variable between 30Hz and 200Hz Cut/boost variable between ±12dB at centre frequency Q approximately 5
High pass (subsonic) filter:	Corner frequency 15Hz, rolloff slope -18dB/octave
Signal to noise ratio:	-80dB unweighted relative to 1V RMS input, 2V RMS output
Maximum output signal:	2.4V RMS
Output impedance:	1kΩ (both outputs)
Amplifier hold-on time:	Approx 11 minutes after end of signals
Power requirements:	Operates from 12V DC, from a battery or regulated plugpack supply. Current consumption 45mA in standby mode, less than 60mA in active mode.

are prevented from reaching the subwoofer, as these can cause its cone to 'flap around' – which can cause unwanted noises and possible damage to the subwoofer.

The Subwoofer Controller unit we're describing here caters for all these conditions. It provides:

- A convenient adjustment of subwoofer upper frequency rolloff, so you can achieve the smoothest possible crossover transition.
- Easy adjustment of subwoofer level, for optimum overall tonal balance.
- A parametric equaliser circuit which allows you to compensate for any response peaks or dips which the subwoofer may have in its operating range, to achieve a smoother response.
- There's also a built-in subsonic high pass filter, which rolls off the response steeply below 15Hz to protect the subwoofer from damage.

Three signal sources

In addition, there is the ability to select between three possible sources for the subwoofer signal: line level outputs from your main amplifier; speaker level outputs or the 'LFE' (low frequency effects) channel output from your DVD player or surround sound decoder; finally there are normal and inverted subwoofer output signals, so you can easily use a stereo amp to drive the subwoofer in bridge mode.

It also has an auto turn-on circuit to switch on your subwoofer's amplifier automatically as soon as it detects the presence of audio signals. Then it holds the amplifier's power on while ever audio signals are being fed to the controller and only turns it off again after waiting about 11-12 minutes from when they are no longer detected.

So you no longer have to worry about remembering to turn on the power to the subwoofer amplifier or off again afterwards.

All of the controller's circuitry fits inside a compact low-profile instrument case and operates from a single 12V DC supply from either a battery or a regulated mains plugpack. The current drain is modest too – less than 60mA when active.

How it works

You can get a good overview of the way the controller works from the block diagram in Fig.1. As you can see, the source select switch is right at the inputs, allowing you to choose between the left and right channel line outputs of your main amplifier if it has them, from the speaker outputs if it doesn't, or from the LFE output of your surround sound decoder or DVD player.

The line and speaker level stereo inputs are each mixed together to produce a mono signal for the Subwoofer Controller but the LFE signal is already mono so mixing isn't required.

The signals are selected by switch S1, then passed through an input buffer stage which allows you to adjust their level (and hence the subwoofer volume) for tonal balancing.

The input buffer uses a feedback-type level control, which can either attenuate or amplify by up to 8dB either way, giving a 16dB adjustment range which will be more than adequate.

Next the signals move to the low pass filter stage which can be adjusted between 41Hz and 200Hz. This allows you to 'fine tune' the crossover frequency where the subwoofer takes over from the main system speakers, to achieve the smoothest transition.

(This filter is not needed when you are using the LFE signal to drive the subwoofer, so in this case you just set the low pass filter frequency to maximum, where it will have minimal effect.)

Next is the parametric equaliser stage, which allows you to compensate for any peaks or troughs (dips) in the subwoofer's own frequency response. It does this by allowing you to produce a counteracting trough or peak at any frequency in the range from 30Hz to 200Hz, and with an amplitude of up to 12dB either way.

This should smooth out most likely

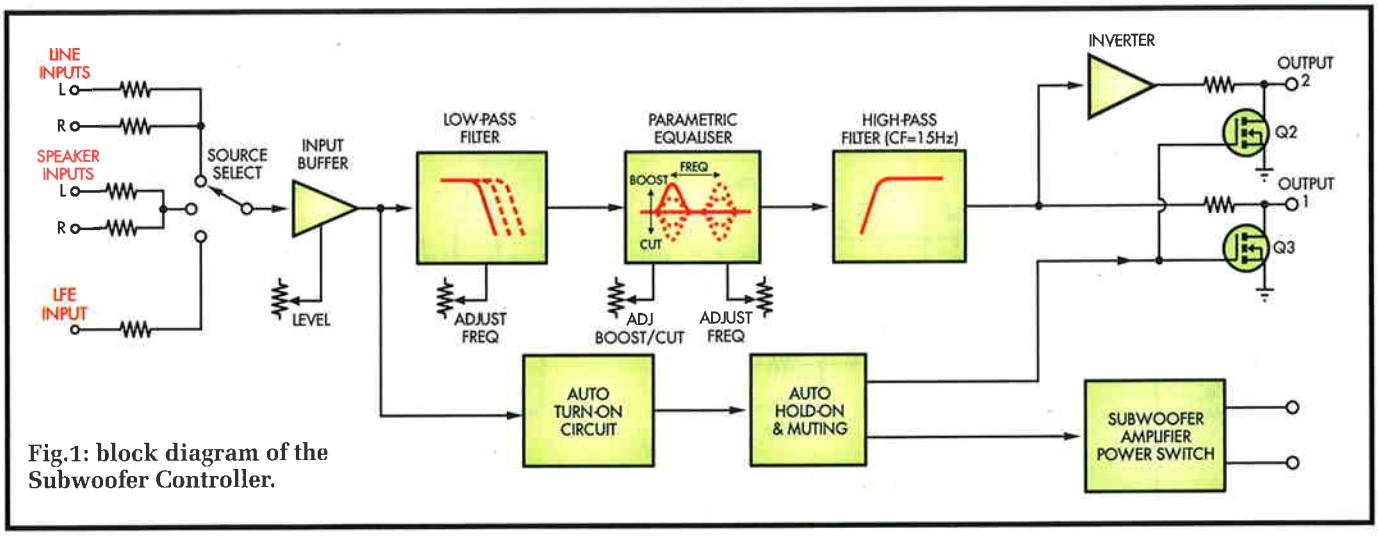


Fig.1: block diagram of the Subwoofer Controller.

peaks or dips in the subwoofer's performance - provided that it's in a reasonably damped enclosure.

Following the equaliser, the signals pass through the subsonic high pass filter. This effectively blocks any rumble or other ultra-low frequency components which could cause trouble for the subwoofer, allowing only 'genuine' (above 15Hz) sub-bass signals to pass through unchanged.

The output from the subsonic high pass filter becomes the main controller output signal for driving the subwoofer amplifier, while a simple unity gain phase inverter stage is used to provide the second 'opposite phase' signal (Output 2).

As mentioned earlier this allows the use of a stereo amplifier to drive the subwoofer in bridge mode. A separate panel in this article explains the concept of amplifier "bridging".

The remaining sections of the controller are used to perform automatic turn-on of the subwoofer amplifier when signals are detected at the output of the input buffer, and also to keep the subwoofer amp switched on until no signals have been detected for the 'hold on' time (about 11-12- minutes). The signal outputs from the controller are muted (by MOSFET switches Q2 and Q3) whenever the controller decides that there are no signals to be passed to the subwoofer.

In more detail

For more insight on how the various sections of the controller work, refer to the main circuit diagram of Fig.2. Again, you'll find the input source selector switch S1 at upper left, with the selected signal passing through a 10µF non-polarised capacitor into the non-inverting (pin 3) input of op amp IC1a, the input buffer stage.

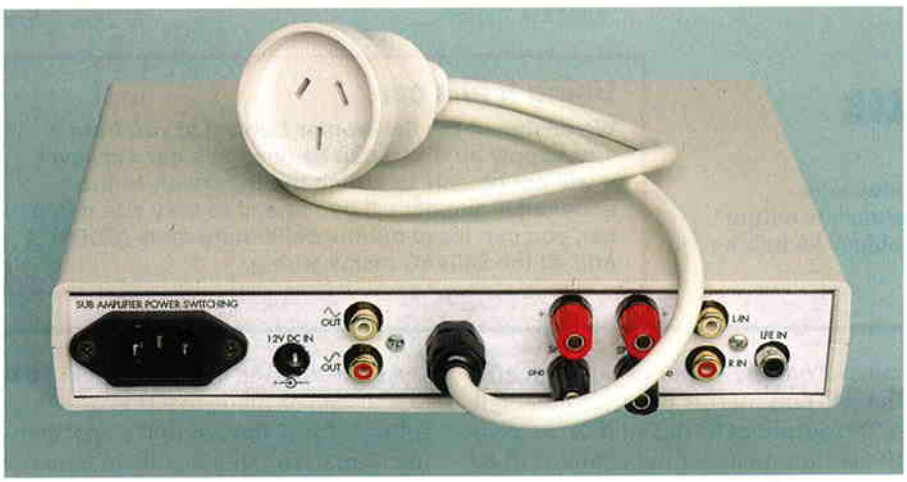
The buffer is configured in a slightly unusual way, to allow its gain to be varied both above and below unity by potentiometer VR1. VR1 varies both the ratio of the input signal divider at pin 3 of IC1a and the gain of the buffer itself, by varying the negative feedback ratio. It does these actions in inverse fashion, to achieve the desired +/-8dB adjustment range. When the wiper of VR1 is in the centre position, the resistor ratios give the buffer an overall gain of unity (0dB).

When the wiper is fully clockwise (ie, back toward IC1a's pin 2), the input divider ratio is reduced while the negative feedback ratio is increased, giving an overall gain of approximately 2.5 (+8dB).

Conversely, when the wiper of VR1 is turned fully anticlockwise (in contact with IC1a's pin 3), the input divider ratio is increased while the negative feedback ratio is reduced, lowering the overall gain to 0.4 (-8dB).

From the output of IC1a (pin 1) the signals pass to the adjustable low pass filter stage, based on IC1b.

This is a standard Sallen & Key active low-pass filter with unity gain in the passband and a cutoff slope of 12dB per octave. Its corner frequency can be varied between 41Hz and 200Hz using VR2a and VR2b, two sections of a dual-ganged 50kΩ pot.

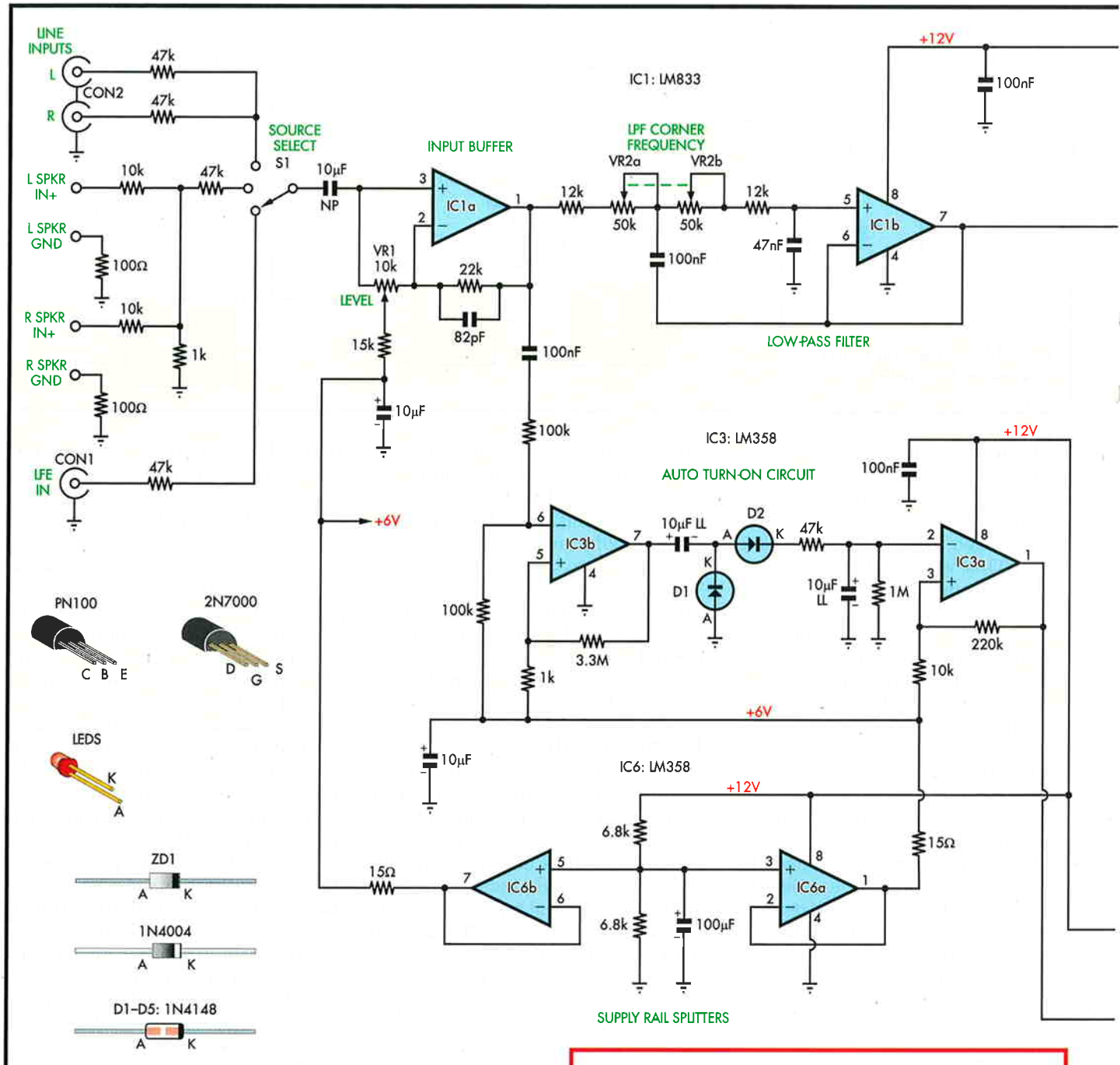


Here's the back end of the prototype Subwoofer Controller showing the inputs and outputs. It's a bit different to the final version (the mains out lead is moved, for example) but this shows the basic arrangement.

Parametric equaliser

The output signal from pin 7 of IC1b then passes to the parametric equaliser stage, based on IC2, a TL074 quad op amp. This is a 'state variable' filter circuit, using multiple feedback paths around two single-pole filter stages based on IC2b and IC2a.

The use of both positive and nega-



SUBWOOFER CONTROLLER

Fig.2: the complete circuit of our new Subwoofer Controller. As well as providing the appropriate output for the subwoofer amplifer, it's also capable of switching it off in the absence of audio signal.

Using it in a car

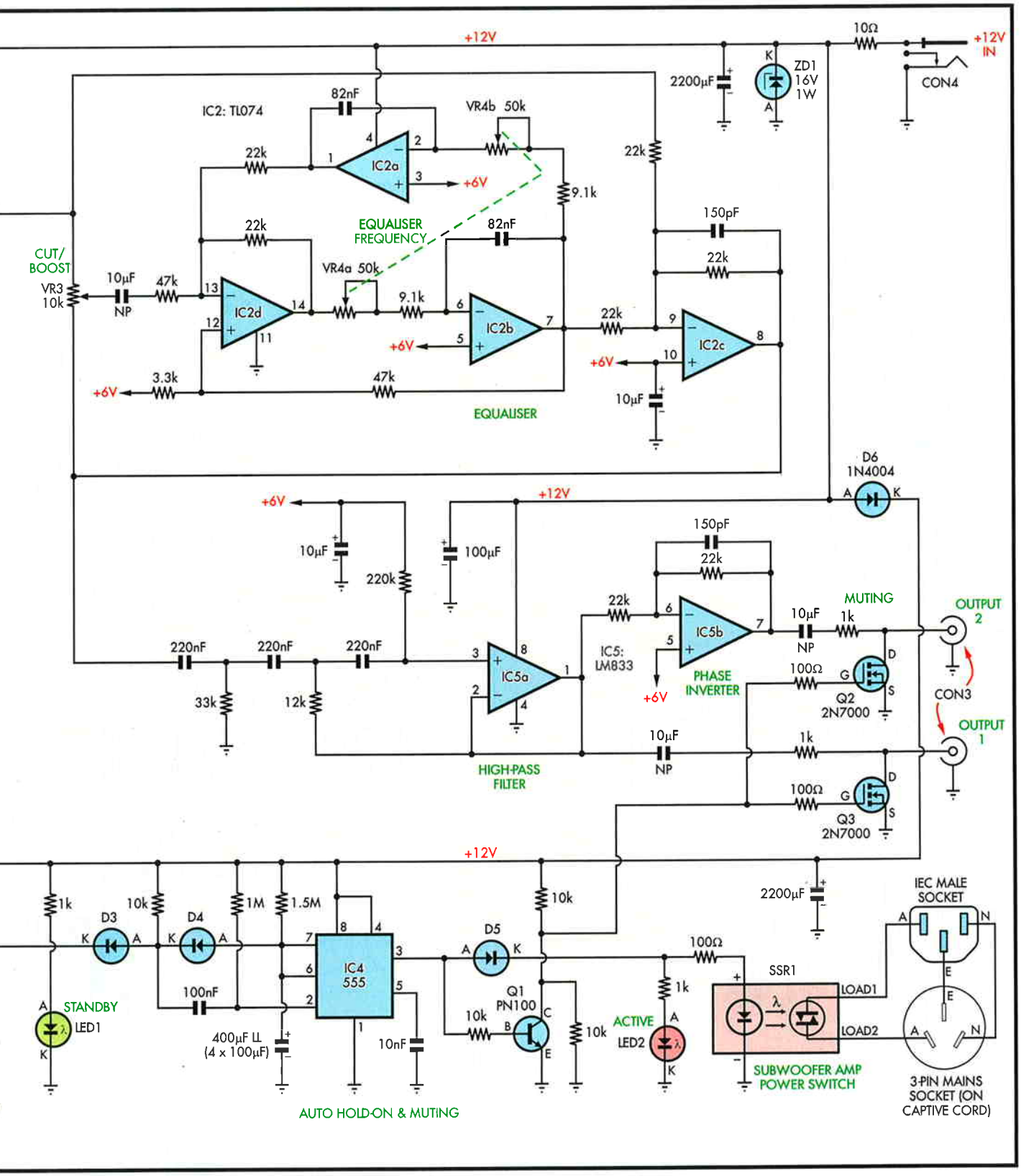
We designed the Subwoofer Control to run from a 12V supply so that it can be used in a car. However, it will not be able to switch the DC power to the subwoofer amplifier. If you intend to only use it in a car, you can leave out the solid-state relay (SSR1) and all the 240VAC mains wiring.

tive feedback results in a bandpass filter characteristic at the output of IC2b (pin 7) and this signal is mixed with the original signal from IC1b in IC2c, an inverting mixer stage with a gain of -1.

Because the input of IC2d (pin 13) is fed from the wiper of pot VR3 and the two ends of this pot are connected to the output of IC1b and IC2c respectively, the phase of the signal sent to IC2d is varied over a 180-degree range as VR3 is turned from one extreme to the other.

As a result, the bandpass signal fed to IC2c can be made to either add to or subtract from, the original signal coming from IC1b. This results in boost or attenuation of the frequencies in the bandpass range, as desired.

Dual ganged pot VR4a/VR4b is used



to vary the centre frequency of the equaliser, while VR3 is used to vary the degree of boost or cut. When VR3 is in its centre position, the equaliser circuit provides unity gain at all frequencies.

From the parametric equaliser stage the signals pass to the high pass filter stage, based around IC5a. This is again a standard three-pole Sallen & Key active high pass filter configuration, with capacitor and resistor values chosen to give a corner frequency of 15Hz. This stage has unity gain in the passband but with a rolloff slope of -18dB per octave, for signals below 15Hz.

The controller's main output signal is fed from the output of IC5a (pin 1) to the OUTPUT 1 connector via a non polarised (NP) 10µF capacitor and a series 1kΩ resistor, while IC5b is con-

nected as a simple unity-gain inverter to produce the opposite phase output signal fed to the OUTPUT 2 connector – again via a 10µF/1kΩ series combination.

As you can see, both output signals are effectively switched on or off (muted) by transistors Q2 & Q3. These are 2N7000 Mosfets which are controlled by transistor Q1 and in turn by the auto turn-on/hold-on circuitry based around IC3 and IC4.

Auto turn-on & muting

The two sections of IC3 perform the signal detection and auto turn-on functions. The output signal from pin 1 of input buffer IC1a is fed to the inverting input (pin 6) of IC3b, via a 100nF coupling capacitor and series 100kΩ resistor (which forms a 2:1 voltage divider with the second 100kΩ resistor from pin 6 to the +6V bias line).

IC3b also has positive feedback applied to it via the 3.3MΩ resistor connected from output pin 7 to

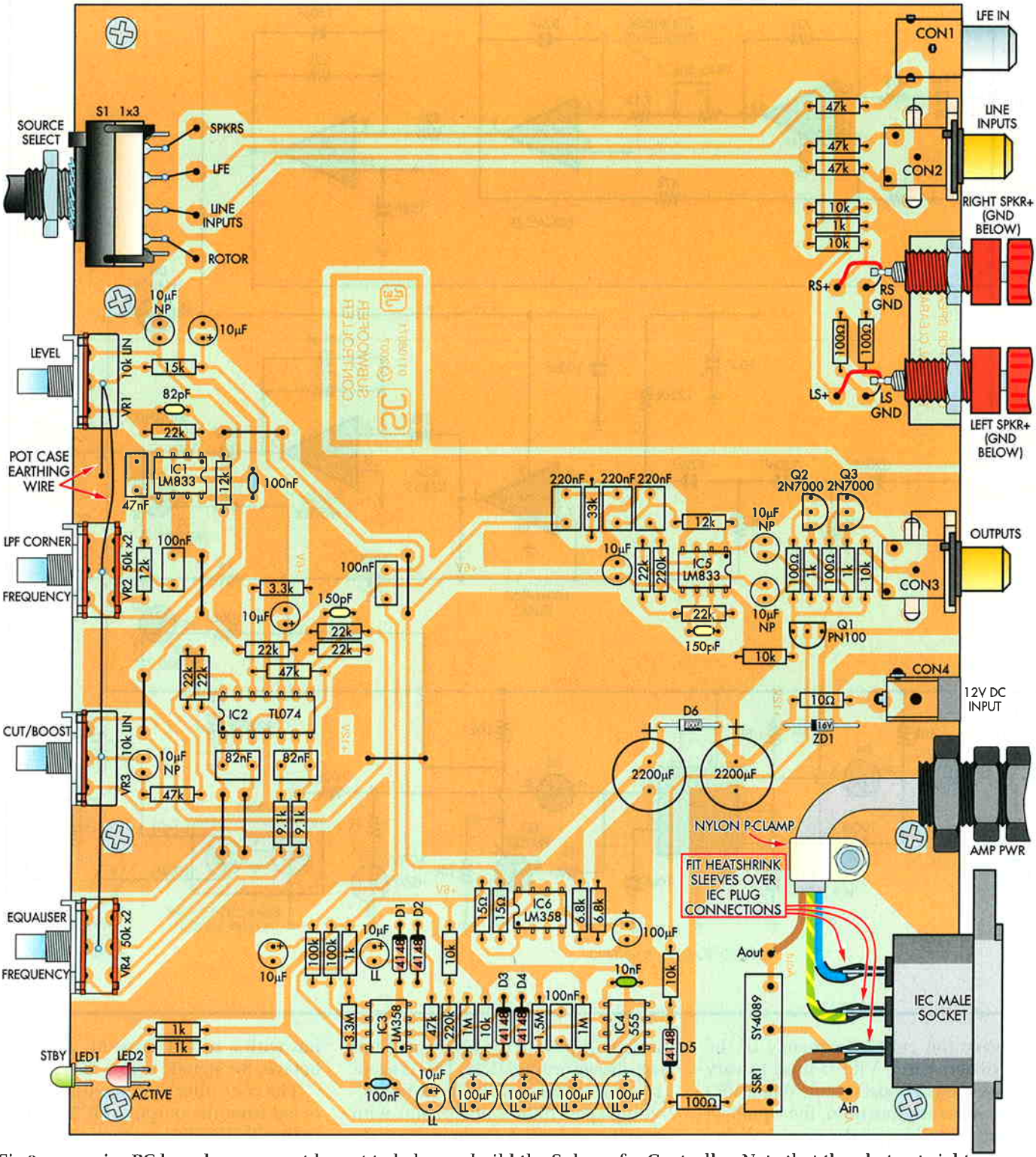


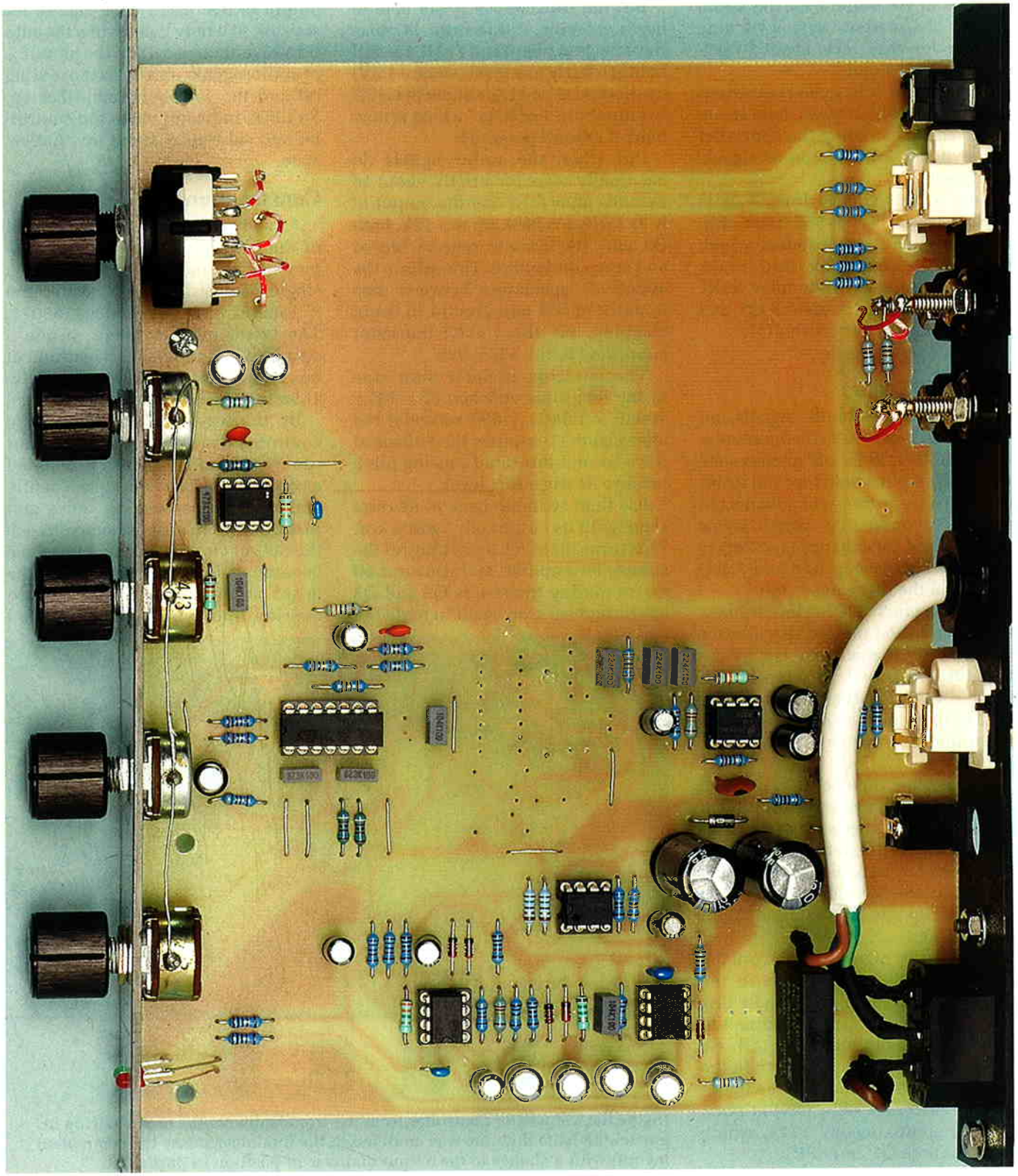
Fig.3: same-size PC board component layout to help you build the Subwoofer Controller. Note that the photo at right is similar but has extra holes for a compressor stage (we decided it was unsatisfactory) and the amp power lead is moved.

non-inverting input pin 5 and so it acts as a Schmitt trigger - producing a square wave version of the audio signal coming from IC1a as soon as that signal's amplitude reaches its triggering level.

The squared-up audio signal from IC3b is then fed to a simple rectifier circuit using diodes D1 and D2, which effectively convert it into a 'signal detected' DC voltage across the 10µF capacitor connected from pin 2 of IC3a to ground. The 47kΩ resistor in series with D2 is used to set the 'attack time' of this control voltage (ie, how quickly it rises after the start of audio signals) to about 200ms (1/5 of a second).

On the other hand, the 1MΩ resistor across the 10µF capacitor sets the signal detector's 'decay time' – how long the control voltage remains high after the audio signals end, approximately 10 seconds. This is long enough to ensure that the control voltage stays high during short pauses in the audio.

The DC control voltage developed across the 10µF capacitor and 1MΩ



resistor is fed directly to IC3a, again configured as a Schmitt trigger, because of the positive feedback from pin 1 to pin 3 via the 220kΩ resistor.

So IC3a's output pin 1, which remains at very close to the +12V level when no audio signal has been detected, suddenly switches to 0V as soon as a signal is detected. And it remains at 0V while ever the audio signals are present, only switching back to the +12V level about 10 seconds after they end.

In short, the voltage level at output pin 1 of IC3a is high when there are no audio signals entering the controller but switches low as soon as signals are present.

This output voltage from IC3a is used to trigger IC4, a 555 timer chip configured as a monostable, which controls the subwoofer amp power switching via solid state relay SSR1 and also muting transistors Q2 and Q3, via switching transistor Q1.

Here's how it works:

Solid-state relay

In the absence of audio signals and with the output of IC3a therefore staying high, IC4 is in its 'off' or reset state with output pin 3 held low and its internal discharge transistor (connected to pin 7) conducting, which keeps the 400µF of capacitance (4 x 100µF) connected between pins 6 and 7 and ground in the discharged state.

Because pin 3 of IC4 is low, transistor Q1 is turned off and its collector voltage rests at about +6V (set by the two 10kΩ resistors). As a result both Q2 and Q3 are turned on, clamping both of the controller's audio outputs to ground and hence keeping them muted.

At the same time because pin 3 of IC4 is low, no current can flow through diode D5 and its series 100Ω resistor to activate solid-state relay SSR1. SSR1 therefore remains off, preventing the subwoofer amplifier from being powered up via the external 3-pin cord socket.

When audio signals do arrive at the controller input, this results in the output pin of IC3a soon switching low. This sudden drop is coupled to the pin 2 trigger input of IC4 via diode D3 and the 100nF capacitor, with the result that IC4 immediately switches into its 'on' or set state. Output pin 3 rises to approximately +12V, which turns on both Q1 and SSR1.

Muting transistors Q2 & Q3 are turned off, removing the muting from the controller's audio outputs, while SSR1 switches on the power to your subwoofer amplifier.

At the same time the discharge transistor at pin 7 of IC4, which has been holding the 400µF capacitance discharged, is now turned off.

But the capacitance is not able to begin charging at this stage, because the voltage at pins 6 and 7 of IC4 is still held at a fairly low level (about +1.2V) by diodes D3 and D4, connected back to output pin 1 of IC3a - which is now held at ground potential.

But when the audio signals do eventually cease (or strictly, about 10 seconds after this) and the output of IC3a switches back up to +12V, both D3 and D4 become reverse biased and stop conducting. This allows the 400µF of capacitance between pins 6 and 7 of IC4 and ground to begin charging, via the 1.5MΩ transistor connected to the +12V line.

The charging is fairly slow due to the long time constant (T = RC = 400µF x 1.5MΩ = 600 seconds) but after about 11 minutes the voltage at IC4's second threshold sensing pin 6 reaches its triggering level.

IC4 then switches back to its reset state, with its output pin 3 going low. This turns off SSR1, switching off the subwoofer amplifier, and also turns off Q1 so muting transistors Q2 and Q3 are turned back on again to mute the controller outputs.

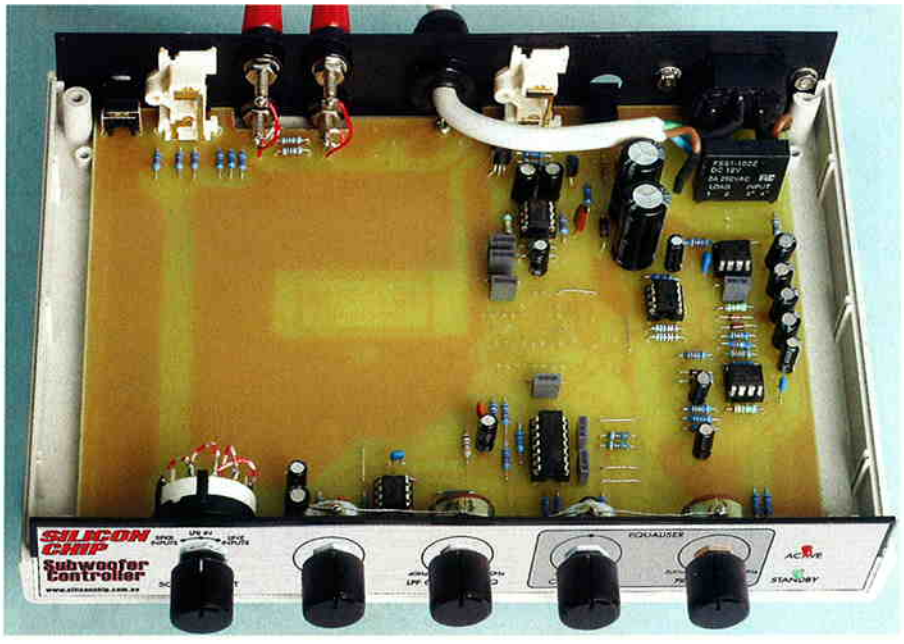
There are two indicator LEDs in the circuit. LED1 is green, connected between the controller's +12V line and ground via a 1kΩ series resistor so it lights whenever +12V is applied to the controller – becoming the 'Standby' LED.

Red LED2 is connected across the output of IC4, again via a 1kΩ series resistor, so it only lights when the auto turn-on circuitry detects the presence of audio signals, and turns the muting off and the subwoofer amplifier on. So LED2 indicates when the controller and subwoofer are in the 'Active' state.

Construction

As shown in the photos, almost all of the controller circuitry and components are mounted directly on a single PC board which measures 200 x 156mm and is coded 01108071. The board mounts snugly inside a standard low-profile ABS instrument box which measures 225mm wide by 165mm deep by 40mm high.

By the way, please note that the controller shown in the photos is our prototype which originally included a compressor stage. We subsequently omitted this because its noise and distortion were unsatisfactory. Hence the output circuit sections have since been moved nearer the centre of the board, as you can see from the board overlay and wiring diagram. You



Inside the Subwoofer controller from the front, showing the mains wiring in particular. Note that this was modified in the final design (see the component layout) with a change to the output mains lead position in particular.

should use the wiring diagram as the main reference for component placement then, rather than the internal photos. The board wiring diagram is shown in Fig.3.

First fit the fixed resistors. These all have their leads bent down to mate with PC board holes spaced 0.4" (10.2mm) apart, with the single exception of the 47kΩ resistor alongside IC2 - which mates with holes spaced 0.5" or 12.5mm apart. Don't throw the resistor lead offcuts away because you can use them to fit the seven ~10mm wire links on the board.

Follow these with the sockets for the various ICs, if you're using them, and then the input and output connectors which are mounted along the rear of the board: CON1 and CON2, CON3 and CON4, then fit trimpot VR5, but not the main control pots at this stage.

Next fit the various small non-polarised capacitors, followed by the electrolytics. Begin with the 10µF caps because there are actually three different kinds of these used in the project: five of the standard polarised 10µF RB caps, two of the low-leakage polarised 10µF RBLL caps and five of the non-polarised 10µF NP RB caps.

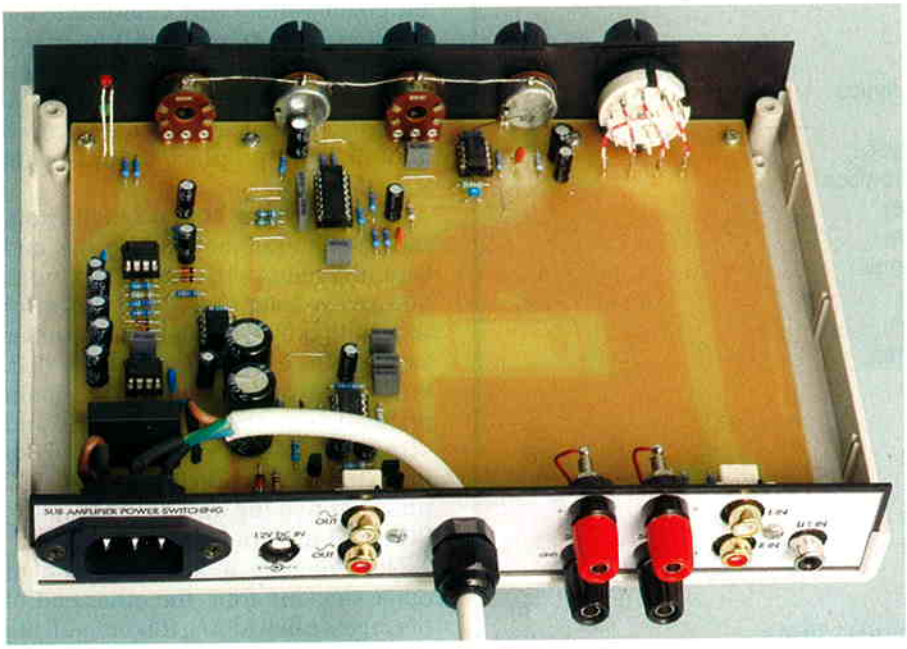
So make sure you fit each type in the correct positions, marked on the wiring diagram with either a simple polarity '+', a '+' and an 'LL' or an 'NP' as the case may be.

All of the remaining electrolytic and tag tantalum capacitors are polarised and must be orientated correctly, as shown in Fig.3.

Once the passive parts are all in place, you can add the five 1N4148 diodes D1-D5, making sure to orientate them correctly, followed by 1N4004 diode D6 and zener diode ZD1, followed by transistor Q1 and finally Mosfets Q2 & Q3. Then you can fit the solid-state relay SSR1, which will only fit one way around.

Now is the time to cut the shafts of control pots VR1-VR4 to about 10mm long, smoothing off any burrs so they're ready to accept their knobs. Do the same with the shaft for switch S1, and while you're doing this it would be a good idea to check S1's stop washer position so it's correctly set for only three switch positions. When the spindles of VR1-VR4 have been cut to length they can all be mounted in position along the front of the board. Note that VR1 and VR3 are both single 10kΩ linear pots, while VR2 and VR4 are dual-ganged 50kΩ units.

Next you need to prepare your front and rear panels by drilling and cutting the various holes in them for the controls and connectors, if the kit supplier hasn't already done this for you. Then or otherwise you can fit switch S1 to the front panel, at the left-hand end. After it's in place you can solder the ends of four 30mm lengths of insulated hookup wire to the rotor lug and those for the first three positions, ready to make the connections to the board when the panels and board have been assembled together.



Similarly, the view from the back panel. The exposed mains (ANE) wires should be as short as possible and anchored to the PC board, as shown in the component overlay, just in case the worst happens and one or more pull loose.

Now fit the IEC mains plug to the right-hand end of the rear panel, using two 10mm long countersink head M3 machine screws with star lockwashers and M3 nuts. Also fit the cable gland for the mains output cord into the next hole in the rear panel, with its large mounting nut on the inside. After this you can complete the rear panel assembly by fitting the four screw terminals used for the speaker level input connections. The two red terminals should go in the upper holes, while the black terminals go in the lower holes.

When all four terminals are in place, carefully solder the ends of two 20mm lengths of tinned copper wire (or resistor lead offcuts) to the rear ends of the two lower terminals, and the ends of two 30mm lengths of insulated copper wire to the rear ends of the two upper terminals. These wires will be used to connect the terminals to the PC board when the rear panel is assembled to it.

The next step is to attach the front panel to the board. This is done by removing the mounting nuts from the threaded ferrules of pots VR1-VR4 (but leaving on the flat washers), then offering up the panel until the spindles and threaded ferrules of pots VR1-VR4 pass through their matching holes. The nuts are then re-applied to the pot ferrules, and screwed up until they are finger tight. This will hold the panel and board assembly together while you make the connections from switch S1 to the board, using the four wires already soldered to the switch lugs.

This is also a convenient time to solder a length of tinned copper wire to the top of the metal case for each of the four control pots VR1-VR4, with the end of the wire passing down through the hole in the PC board midway between VR1 and VR2, about 6mm from the board's front edge. The wire is then soldered to the copper underneath, to make sure all four pots are earthed for minimum hum pickup and to prevent any hand capacitance effects.

At this stage you can also fit the two LEDs at the right-hand end of the front panel, dressing their leads so they pass down through the board holes without strain. Make sure you have both LEDs oriented with their longer anode leads towards the left (i.e., towards VR4).

Parts List – Subwoofer Controller

1 Low profile ABS instrument case, 225 x 165 x 40mm
1 PC board, code 01108071, 200 x 156mm
1 Single pole 3 position rotary switch (S1)
1 RCA socket, PC board mounting (CON1)
2 Dual RCA sockets, PC-mounting (CON2, CON3)
1 2.5mm concentric DC socket (CON4)
1 panel-mounting IEC male mains socket
2 Screw terminal, red
2 Screw terminal, black
5 16mm diameter knobs, black aluminium
5 8-pin DIL sockets
1 14-pin DIL socket
1 Cable entry gland (for 3-6.5mm cable diameter)
1 Plastic cable clamp (Jaycar HP-0754)
3 20mm lengths of 6mm OD heatshrink sleeving
1 Solid state relay, 250V 2A zero voltage switching
1 Length of 3-core mains flex with 240V outlet socket
1 150mm length of 0.25mm or 0.3mm tinned coper wire
2 10mm long countersunk head M3 machine screws with M3 nuts and star lockwashers
8 6mm long small self-tapping screws

Semiconductors

2 LM833 dual low noise op amps (IC1,IC5)
1 TL074 quad op amp (IC2)
2 LM358 dual op amps (IC3,IC6)
1 555 timer (IC4)
1 PN100 NPN transistor (Q1)
2 2N7000 Mosfets (Q2,Q3)
1 16V 1W zener diode (ZD1)
1 3mm green LED (LED1)
1 3mm red LED (LED2)
5 1N4148 silicon diodes (D1-D5)
1 1N4004 1A silicon diode (D6)

Capacitors

2 2200µF 16V RB electrolytics
2 100µF 16V RB electrolytics
4 100µF 25V RBLL low leakage electrolytics
4 10µF 16V RB electrolytics
2 10µF 50V RBLL low leakage electrolytics
4 10µF 50V RBNP non-polarised electrolytics
3 220nF 100V MKT metallised polyester
3 100nF 100V MKT metallised polyester
2 100nF 50V multilayer monolithic ceramic
2 82nF 100V MKT metallised polyester
1 47nF 100V MKT metallised polyester
1 10nF 50V multilayer monolithic ceramic
2 150pF disc ceramic
1 82pF disc ceramic

Resistors (0.25W 1% unless specified)

1 3.3MΩ	1 1.5MΩ	2 1MΩ	2 220kΩ
2 100kΩ	6 47kΩ	1 33kΩ	8 22kΩ
1 15kΩ	3 12kΩ	7 10kΩ	2 9.1kΩ
2 6.8kΩ	1 3.3kΩ	6 1kΩ	5 100Ω
2 15Ω	1 10Ω		

2 10kΩ linear pot, 16mm PC -mounting (VR1,VR4)
2 50kΩ x2 ganged linear pot, 16mm PC-mounting (VR2,VR3)

When both LEDs are in place, invert the assembly and solder their leads to the board pads.

Next you can offer up the rear panel assembly to the rear of the PC board, so the outer sleeves of RCA connectors CON1, CON2 and CON3 pass through their matching holes in the panel. You can then fasten the two together using two 6mm long self-tapping screws, through the centre mounting holes for CON2 and CON3.

Once this has been done, you can connect the four wires from the rear of the speaker line input terminals to the board underneath. The shorter tinned copper wires from the lower terminals pass down through the rearmost holes, while the ends of the longer insulated wires from the upper terminals pass down through the holes nearer the front of the board (marked LS+ and RS+ in the wiring diagram). Then the assembly is inverted again and the wires soldered to the PC board tracks.

The last wiring to be done is that for the subwoofer amp's mains switching, just behind SSR1.

This is not difficult to do, but you need to do the wiring carefully to eliminate the risk of electric shock.

Begin by preparing the cable for the mains output cable. If this doesn't have a cord-type 3-pin socket already attached to one end, fit the socket carefully in the manner recommended by the manufacturer. Make sure that the green/yellow wire connects to the Earth contact screw, and the brown and blue wires to the Active and Neutral screws respectively. Then slide the socket's outer sleeve over the screws and click it into place to make sure it's safe again.

Next cut off a 50mm length from the other end of the mains cable, and carefully remove the outer sleeving so you can extract the 50mm length of wire with brown insulation. The other two lengths of wire can be discarded, but the brown wire should have 5mm of insulation removed at each end - because you'll be using it shortly to make the connection between the IEC plug's Active lug and the hole in the PC board underneath.

Now remove a further 45mm of outer sleeving from the other end of the mains cable, doing this carefully to avoid damaging the insulation on the three wires inside. Then remove about 5mm of insulation from the ends of all

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three wires, tinning them lightly with the soldering iron so the strands are soldered into a compact group.

The outer sleeve of the cable gland can now be unscrewed from the gland on the rear panel, and slipped over the free end of the cable. This end of the cable can then be pushed through the gland's inner hole (from the outside, of course), far enough to allow you to make the cable connections.

But before you make the connections, slide a 20mm length of 6mm heatshrink sleeving down over the blue and green/yellow wires, pushing them down as far as they'll go. You'll then be able to solder the blue wire to the Neutral (N) lug on the IEC plug, the green/yellow wire to the centre earth (G) lug on the plug, and the brown wire to the PC board - in this case by passing it down through the 'Aout' hole near the end of SSR1.

Then when all three wires have been soldered (and the joints have cooled down), slide the heatshrink sleeves on the blue and green/yellow wires up and over the solder joints on the IEC plug and in fact over all exposed metal of the lugs, and then apply heat from your soldering iron or a hot air gun so the sleeves shrink down to attach them in place.

One end of your 50mm length of brown insulated wire can now be soldered to the remaining Active (A) lug on the rear of the IEC plug. After the solder cools, you can then slide your remaining 20mm length of heatshrink sleeving up from the free end of the wire and over the solder joint and any remaining exposed lug. Then heat the sleeving as before, to shrink it down around them and prevent accidental contact. Finally the free end of this wire can be passed down through the 'Ain' hole in the PC board below, and soldered carefully to the pad underneath.

To complete this assembly stage, pull the mains output cord back through the cable gland until there's only just enough cable inside the gland to avoid any strain on the soldered connections. Then slide the outer sleeve of the gland up the cable and thread it on the threaded ferrule, until the gland contracts enough to clamp the cable quite firmly.

Do not forget to add the plastic cable clamp to provide further anchorage of the mains cord. It might seem superfluous but it is there to anchor the cord in case the soldered connections subsequently fail; this might cause the Active conductor to come into contact with the signal circuitry.

Your board and panels assembly will now be complete and ready to lower into the lower half of the box, although before this is done you'll need to cut off three of the spigots moulded into the box lower half, to clear some of the soldered joints under the board. The three spigots to be cut off are the one at centre front, to clear the joints under VR2; the one at centre rear, to clear the joints under CON3; and the one in the left rear corner, to clear the joints under CON1. All other spigots can be left intact.

Once the three spigots are cut short, the board and panel assembly can be lowered into the bottom of the box with the ends of the panels sliding down in the slots provided for them. Then the assembly can be fastened in place using six 6mm long self-tapping screws, passing through the four mounting holes along the front of the board and the two along the back, all of which align with matching support spigots.

Now you should be able to plug all of the ICs into their sockets, doing this carefully so that each one is orientated

correctly and none of their pins is bent out of shape.

All that remains is to tighten up the mounting nuts for S1 and the four control pots on the front panel so they won't work loose, and then fit the five control knobs. Your Subwoofer Controller should then be functionally complete and ready for a quick checkout.

Checkout & adjustment

To prepare it for checkout, first switch S1 to select the speaker terminal inputs, and also set pots VR1 (Level) and VR3 (Cut/Boost) to their midrange positions. Then connect the Controller's DC input socket CON4 to a suitable source of 12V DC, such as a battery or a regulated 12V plug pack. Make sure that the plug mating with CON4 is wired so that the centre pin becomes positive.

As soon as the power is applied, the only activity you should see is that Standby LED1 lights up. If it doesn't light, you make have fitted it to the board with reversed polarity, so switch off and check this -- remedying it if necessary.

The only other likely reason for LED1 not lighting up is that you've managed to connect the 12V supply with reversed polarity. If this is the case, there will probably be another sign: a small cloud of smoke arising from the 10Ω resistor just behind CON4, because this resistor will be dissipating about 10 watts of power and burning up. Obviously the thing to do in this event is switch off immediately, and reverse the DC input plug connections. If you do this quickly enough, the resistor may not need to be replaced.

Assuming that all is well so far, you may want to use your multimeter to measure the current being drawn from the 12V supply. It should measure 45mA or less, with the Controller in its 'standby' state. If that's what you find, your Controller's circuitry is probably functioning normally.

Now connect a source of line level (i.e., 250mV - 1V RMS) audio signals to the Controller's LFE input socket CON1. The signals can be from an audio generator if you have one (set to say 200Hz), or otherwise the audio from a CD/DVD player or a radio tuner. Then switch S1 to its centre 'LFE' position, and within about half a second LED2 should light up to indicate that the auto power-on circuitry has detected the incoming signals, and switched the controller into its 'active' state. (If you are still monitoring the Controller's battery current with your multimeter, this will show the current has increased to about 55-60mA.)

If you then switch S1 back to the original Speaker Inputs position, LED2 should remain alight for about 11-12 minutes, showing that the auto hold-on circuitry is also working correctly. But then it should turn off again, as the Controller switches back into Standby mode.

Putting it to use

The Subwoofer Controller is intended to connect into your audio system just ahead of the amplifier that you're using to drive the subwoofer. If this amplifier is a mono one, you only need to feed its input from the Controller's upper socket of CON3: Output1. However if you're using both channels of a stereo amplifier to drive the subwoofer in bridge mode (for extra power), you'll need to feed its two inputs from both of the Controller outputs.

The input signals for the Controller will normally be derived from either the LFE output from your DVD player or surround sound decoder or ideally, from line level outputs on your main amplifier - assuming it has some. In this case you simply use a stereo RCA-RCA lead to connect the amp's line level outputs to the two Controller inputs of CON2. In most cases it's not really feasible to use an amplifier's recording outputs by the way, because these generally provide signals tapped off before the main volume controls (so they are uncontrolled and 'full bore' all the time). You need line level outputs that are controlled by the main volume controls, so the balance you set between the main speakers and the subwoofer is not upset as soon as you adjust the main volume.

If you don't have controlled line level outputs available from the main amplifier, the alternative is to derive the signals for the Controller from the main amp's speaker connections. This is again quite easy, involving a couple of lengths of light duty figure-8 flex connecting the main speaker terminals of the amplifier to the terminals on the rear of the controller. Just make sure you don't reverse the connections at

Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
1	3.3MΩ	orange orange green brown	orange orange black yellow brown
1	1.5MΩ	brown green green brown	brown green black yellow brown
2	1MΩ	brown black green brown	brown black black yellow brown
2	220kΩ	red red yellow brown	red red black orange brown
2	100kΩ	brown black yellow brown	brown black black orange brown
6	47kΩ	yellow violet orange brown	yellow violet black red brown
1	33kΩ	orange orange orange brown	orange orange black red brown
8	22kΩ	red red orange brown	red red black red brown
1	15kΩ	brown green orange brown	brown green black red brown
3	12kΩ	brown red orange brown	brown red black red brown
7	10kΩ	brown black orange brown	brown black black red brown
2	9.1kΩ	white brown red brown	white brown black brown brown
2	6.8kΩ	blue grey red brown	blue grey black brown brown
1	3.3kΩ	orange orange red brown	orange orange black brown brown
6	1kΩ	brown black red brown	brown black black brown brown
2	150Ω	brown green brown brown	brown green black black brown
5	100Ω	brown black brown brown	brown black black black brown
1	10Ω	brown black black brown	brown black black gold brown

Capacitor Codes

Value	µF code	IEC Code	EIA Code
220nF	0.22µF	220n	224
100nF	0.1µF	100n	104
82nF	.082µF	82n	823
47nF	.047µF	47n	473
10nF	.01µF	10n	103
150pF	NA	150p	150
82pF	NA	82p	82

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either end, or the bass components in the two signals (right and left) will subtract and cancel rather than add together.

By the way the connections to the main amp speaker terminals won't disturb the operation of the main speakers, because these Controller inputs are high in impedance – over 10kΩ – much higher than the speakers. There are also small resistors connected in series with the two 'negative' speaker inputs of the Controller, so connecting them both doesn't create any significant earth loop.

The only other connections required for the Controller are to allow it to control the power to the subwoofer amplifier. All that's needed for this is to connect the amp's power lead to the 3-pin socket on the end of the Controller's mains cord, and then to supply power to the Controller's IEC mains plug using a standard 3-pin plug to cable IEC socket cable, as used for most computers, peripherals and many other modern appliances.

Note that the mains power supplied to the Controller's IEC plug is used purely for running the subwoofer amplifier. The Controller itself operates entirely from the external 12V DC source.

Once everything is connected up, setting up the Controller doesn't really involve a lot of fancy test instruments - although you could of course use instruments like a sound level meter if you have them. In most cases it will be quite sufficient to find the correct control settings by ear, using a suitable music CD or DVD movie soundtrack.

The procedure is quite straightforward. First select the input signal source you're using, via S1. Then set both of the Controller's pots VR1 and VR3 to their midrange positions, and also both VR2 and VR4 to their midrange positions. You should then be able to hear the audio signal's low bass components emerging from the subwoofer. If they're either not audible or too low in volume, try turning VR1 clockwise until they do rise to a level which matches the higher frequency components from the main speakers. On the other hand if the low bass is already too high in level and tending to 'boom', turn VR1 anticlockwise until the subwoofer level comes down to match that of the main speakers.

Should you find that the low bass is still too low in level when VR1 is turned fully clockwise, you will need to turn up the volume control on the subwoofer amp itself. But don't turn it up any further than is absolutely necessary, because this may increase the risk of subwoofer overload on sudden bass peaks.

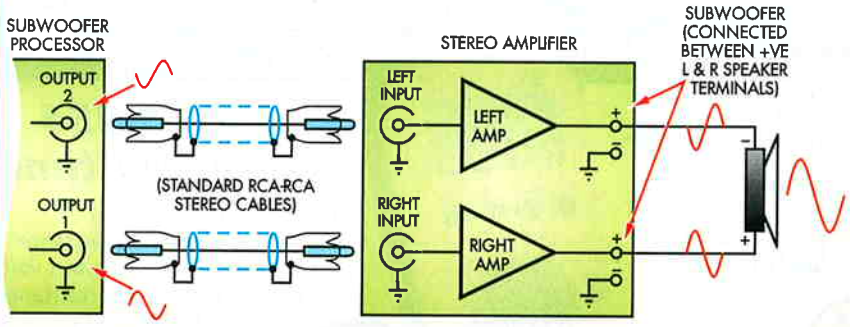
Once you have the subwoofer's overall level balanced fairly well against the main speakers, listen carefully to see if you can detect any 'peak' or 'trough' in the overall system response, in the transition region where the response of the main speakers is tapering off and the subwoofer is taking over.

A peak will make itself evident as some residual 'boom' or over-loud sound, especially in the frequency range from 100Hz to 200Hz.

On the other hand a dip will cause the bass to sound weak, especially in the same region of frequencies.

If you believe you do have a response 'peak' in the transition region, try turning the LP corner frequency control VR2 slowly anticlockwise. This lowers the frequency where the

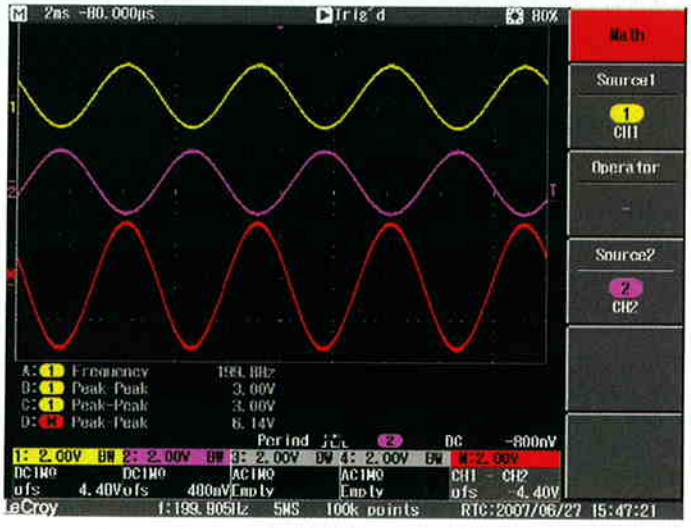
Amplifier bridging explained



Many readers wonder about the principle of amplifier bridging and how to do it.

In effect, it allows the two channels of a stereo amplifier to drive one loudspeaker and thereby deliver maximum power. To do so, the loudspeaker must be connected to the two active (+) speaker outputs on the stereo amplifier, leaving the earth (–) outputs unconnected. We then feed the same mono signal to the amplifier inputs but the phase of one signal reversed.

So if we have a 100W per channel amplifier (into 8Ω loads), the maximum undistorted signal available from each channel output will be 28.28V RMS or 80V peak-peak. However, if we consider that with our phase reversed input signal to one channel, the total voltage available across the loudspeaker will now be 56.56V RMS or 160V peak-peak. With an 8Ω loudspeaker, this equates to a maximum undistorted power of 400 watts RMS.



We have illustrated the principle with the above scope screen shot. The two upper traces show the out-of-phase signals. The red trace is produced by the MATH function of the scope, with one signal subtracted from the other to give a resultant doubling in the peak-to-peak voltage.

Mind you, amplifier bridging does not work quite this well in the real world. Few amplifiers can deliver four times their rated single channel power in bridge mode.

Nor can few amplifiers deliver twice their 8Ω power into a 4Ω load from each channel which is exactly the situation here.

While an 8Ω loudspeaker was suggested, the load "seen" by each amplifier channel will be 4Ω.

This means that any amplifier to be used for bridging must be capable of driving half the loudspeaker's nominal impedance from each channel.

subwoofer begins to take over, which should reduce the peak. So stop turning VR2 as soon as the over-loud bass in the 100Hz-200Hz region seems to have gone.

Conversely, VR2 is turned slowly in the clockwise direction if you seem to have weak bass, caused by a dip in the transition region.

This increases the frequency where the subwoofer begins to take over, and hence allows it to 'fill in the dip'. But again it's a good idea to stop turning VR2 as soon as the dip seems to have gone, or you may well begin to create a bump.

The Controller's two remaining controls, VR3 and VR4, are mainly provided to allow you to compensate for any unevenness in the subwoofer's own response.

For example if it has an unpleasant response peak at a particular frequency – say 80Hz – you can use VR4 to tune the equaliser's centre frequency to match the peak, and then turn VR3 anticlockwise to reduce the signal level at that frequency to smooth the overall response by cancelling the peak.

Conversely if the subwoofer has a response dip at a particular frequency, you can use VR4 to tune the equaliser to that frequency and then turn VR3 slowly clockwise to boost the signal level at that frequency and again smooth the response by 'filling in the dip'.

This is the main purpose for the Controller's parametric equaliser controls, then: lopping peaks or filling in dips in the subwoofer's own response. However if they are really not needed for this, because you have a subwoofer with a particularly smooth response, the controls can instead be used for carefully extending the subwoofer's low bass response a little.

The idea here is to turn VR4 anticlockwise (to the 30Hz end), and then slowly turn VR3 clockwise to boost these very low frequencies relative to those above the subwoofer's own cutoff frequency.

You shouldn't expect to achieve a dramatic extension in low bass response this way but if your subwoofer is already pretty good, you may be able to make it sound even better.

Don't overdo this extra sub-bass boost though, because the subwoofer might end up being overdriven and damaged. That could be very expensive. SC

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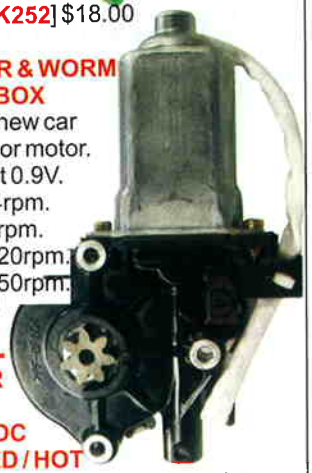

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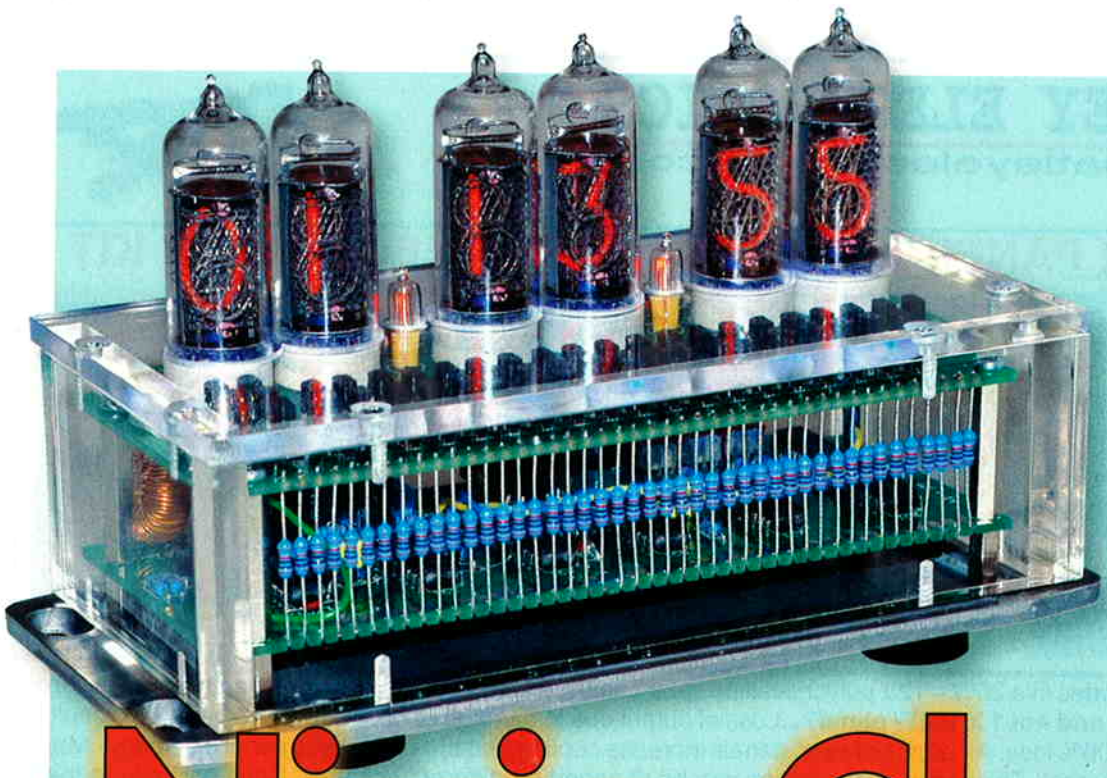


Nixie Clock

Building This Eye-Catching Retro Project

Pt.2: Design by DAVID WHITBY

Last month, we gave some of the history of Nixie tubes and described the design of the NX14 clock and its circuit. This month, we give the assembly details and describe the optional blue LED up-lighting which we think that most constructors will definitely want, together with the attractive see-through Perspex case.

THE NX14 NIXIE CLOCK is built on two double-sided, plated-through-hole PC boards, each measuring 147 x 60mm.

The upper PC board is coded NX14U and holds the six Nixies and their associated current limiting resistors, the two neon "hours" and "minutes" bulbs with their resistors and the 44 high-voltage driver transistors. This board also takes the optional six 3mm blue LEDs and their two current limiting resistors.

The lower PC board

We'll start assembly with the lower board – see Fig.1. It is coded NX14L and carries the power supply, crystal oscillator and all the dividing/counting circuits. The 1F (yes, one Farad!) super capacitor is mounted underneath this board along with four 10mm mounting spacers and the mini toggle off/on switch for the blue LEDs (if required).

In the kit, both PC boards come packed with their own components, separated into the different component types to simplify assembly. After checking the board for faults such

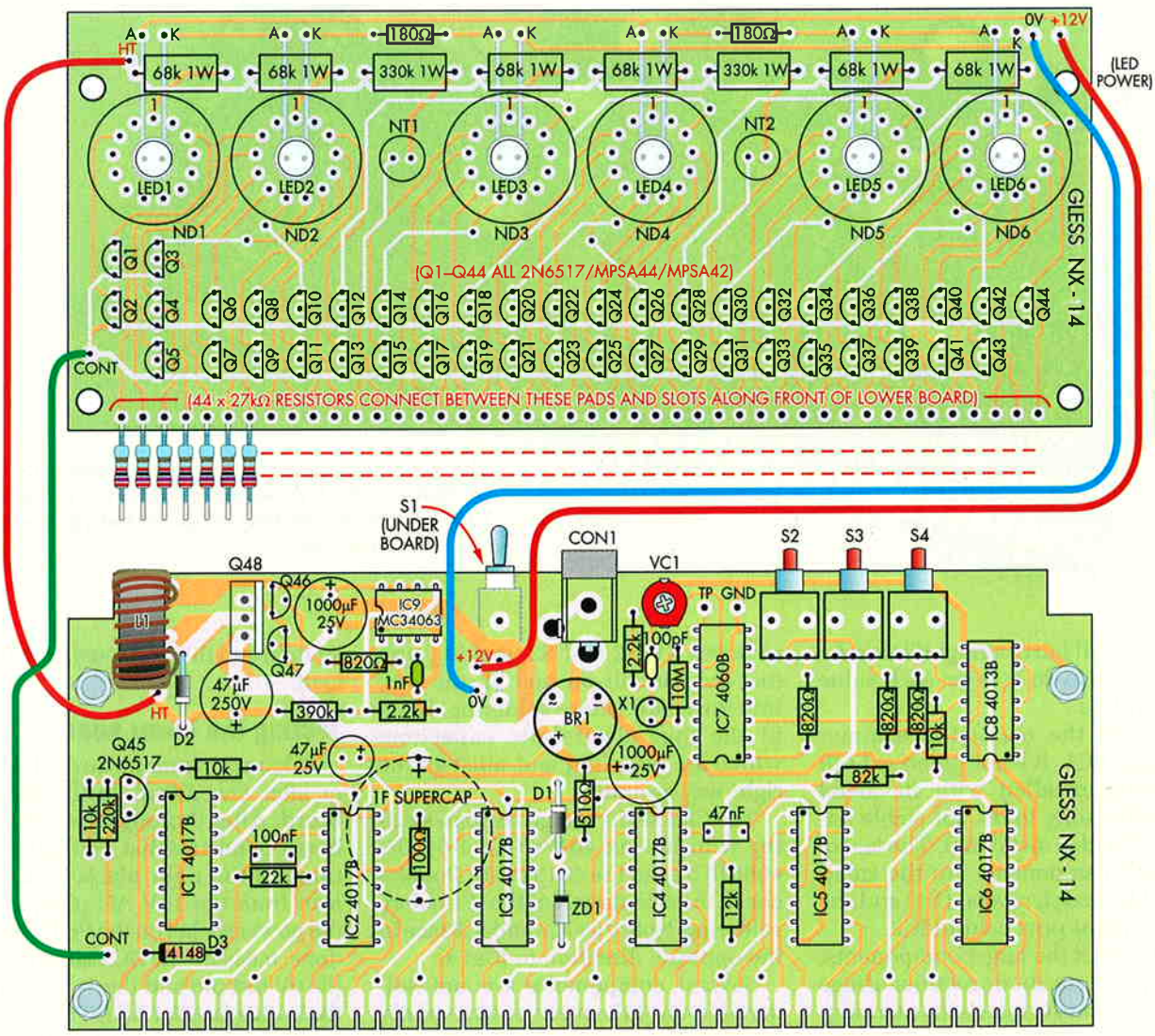


Fig.1: install the parts on the two PC boards and run the wiring connections as shown here to assemble your Nixie clock. Note that the six blue LEDs for the optional up-lighting (ie, LEDs 1-6) are installed on the rear of the top board – see photo. Switch S1 and the 1F supercap are installed on the rear of the bottom board.

as bridged tracks or blocked plated-through holes, begin by installing all 17 resistors in the board.

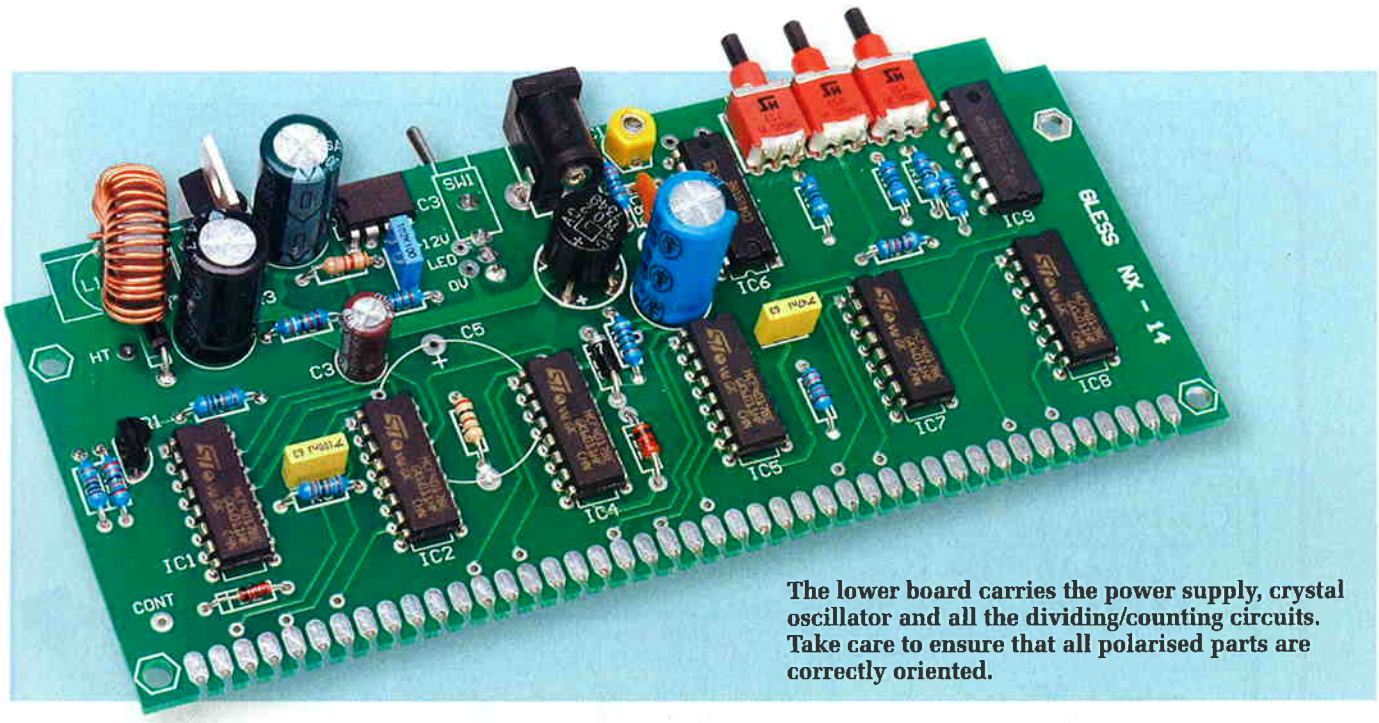
Before soldering the resistors and cutting their pigtails, double check that you have the right values in the right holes. If you are unsure of any of the resistor values, double check them with a digital multimeter as the colour codes can be difficult to read.

Next, install the three diodes and the zener diode. These are all different, so take care to place them in the correct positions and with the right polarity. D3 (1N4148 or 1N914) and ZD1 will be in small glass packages while the other two are in black plastic encapsulation. These might look the same but they are not! D1 is a common 1N4007 1A power diode while D2 is a UF4004 1A high speed switching diode, for the high frequency HT power supply. Make sure you read the labelling before you install them. **If you get these mixed up the HT supply may not work at all or it might get very hot.**

The three small plastic TO92 transistors can go in next and once again, these are three different types so take care to place each of them in their correct positions. It is particularly easy to mix up Q46 and Q47 which are mounted next to each other in the HT supply area. Q46 is a BC337 and goes nearest to the edge of the PC board while Q47 is a BC327 which goes next to it but faces the other way.

Don't fit Q45 at this stage. It's the same type as used on the upper PC board; it could be a 2N6517 or MPSA42 or MPSA44. Similarly, the only other transistor (Q48 – IRF740 power Mosfet) is not installed at the moment. This disables the "bitey" HT generator until after the clock DC supplies and circuitry are tested. It's not good idea to have 200-230V around while testing the CMOS clock circuitry and handling the board!

Next, fit the small non-polarised capacitors. These are the three small rectangular MKT capacitors (1nF, 47nF and 100nF) and a small 100pF ceramic capacitor near the crystal oscillator (IC



The lower board carries the power supply, crystal oscillator and all the dividing/counting circuits. Take care to ensure that all polarised parts are correctly oriented.

7). They're all fairly straightforward – all you have to do is to get each value in right place.

Next, fit the oscillator trimmer capacitor, VC1. It's not polarised but should be installed with its metal screw slot going to 0V, for stable adjustment with a metal tool. The last of the small components are the small 32.768kHz watch crystal (X1) and the two test-point pins behind IC7.

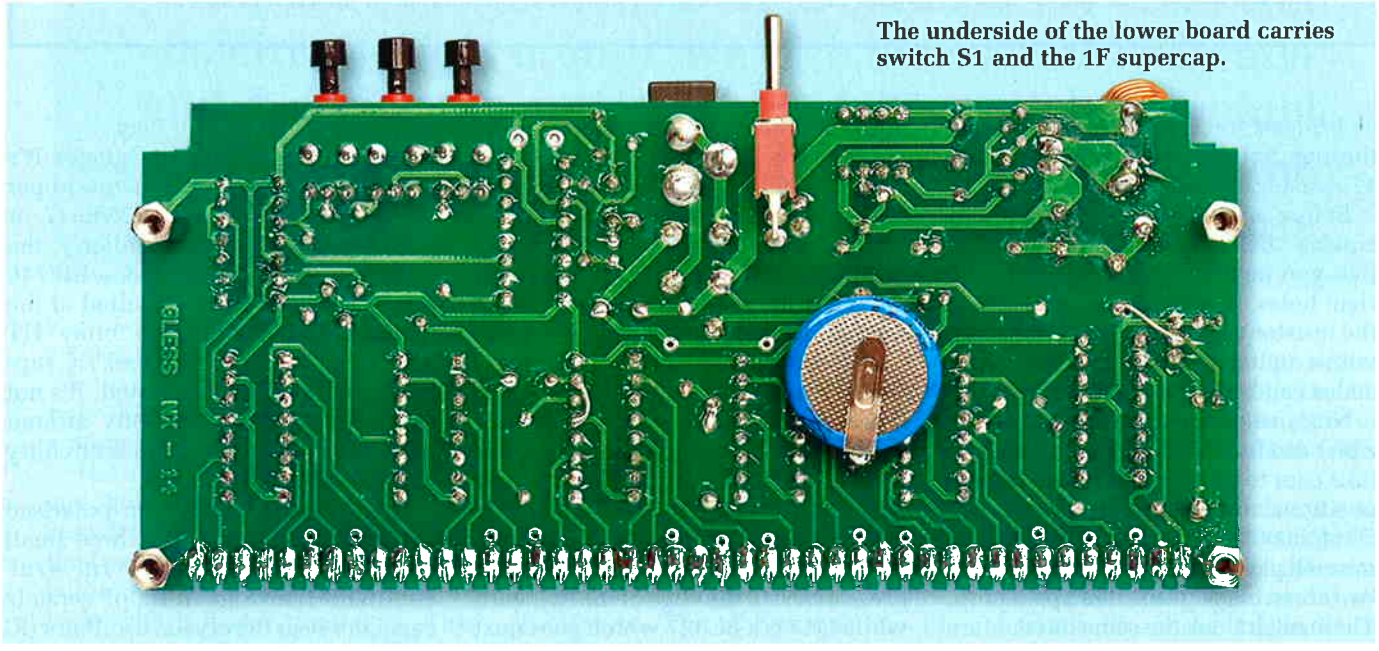
Now install the larger components, starting with the diode rectifier bridge (BR1). Take care to match the markings with the PC board component overlay. Install the power socket (CON 1) and switches S1, S2 and S3, making sure that they are all pushed all the way into the board before soldering. Then fit the four electrolytic capacitors which are polarised and must go the right way around.

The CMOS ICs can go in next, starting with the six 4017s (ICs 1-6), the 4060 (IC7) and the 4013 (IC8). Double-check the orientation of the ICs before soldering. Note that IC7 and IC8 face in the opposite direction to ICs1-6.

Several components are not soldered in until the main power supply is tested. These are the MC34063 (IC9), L1, the 1F supercap, S1 (the blue LED switch) and the previously mentioned Q48.

Testing the lower board

It doesn't matter if you do this before or after you assemble the upper PC board. After thoroughly checking the board to ensure that you have everything in the right place, connect the lead from the 10V AC plugpack into the power socket on the PC board. That done, measure the DC voltage between the 0V test pin and the "+" terminal of the bridge rectifier BR1. This should be between 11V and 14VDC, depending on the AC mains voltage.



The underside of the lower board carries switch S1 and the 1F supercap.

The upper board carries the six Nixie tubes, the two Neons and the 44 segment driver transistors. Make sure the Nixie tubes are seated correctly before soldering their leads.

Next, check the voltage between 0V and pin 16 of IC7 – it should be between 5.4V and 5.5V. If all is OK so far, check that the crystal oscillator is working. If you have an oscilloscope or frequency counter, look for 32.768kHz at the test point. Otherwise, using a multimeter, look for 2Hz (5V) on pin 3 of IC7 or 1Hz on pin 13 of IC8 (on an analog meter you can see the pointer flicking at these rates). This will confirm that all is well up to the input of the clock counter/divider chain.

If you do have a frequency counter this would be a good time to set the oscillator to exactly 32.768kHz.

The only simple way to test the counting/dividing circuitry is with the display in the finished clock so now you can fit the remainder of the HT supply components – ie, IC9, L1, the 1F supercap, S1 (the blue LED switch) and Q48.

The HT supply

With the HT components installed, wire the supplied coloured leads to the board. A 22kΩ 3W test resistor will be supplied in the kit to make testing the HT supply safer. Connect this temporarily between the red HT wire and the blue 0V wire.

Be careful: the HT is around 220–230V DC! This can give you a strong shock if you come into contact with it, so don't handle or work on the project when the plugpack is connected to the PC board. Wait at least two minutes after disconnecting the power for the 4.7µF 250V capacitor to discharge before handling or working on the board.

So having taken all care, connect the power and measure the HT voltage. It should be between 200V and 230V DC across the 22kΩ test resistor. If all is well, then remove the power, wait two minutes and fit the 1F supercap and the blue LED switch S1 (if required) to the underside of the PC board.

The 1F supercap is polarised, so take care to get it the right way around. The markings are sometimes not obvious – the negative lead is the one that is folded over from the metallic patterned side of the capacitor. A self-adhesive pad will be supplied with the supercap for insulation and spacing. Its terminal pins need to be soldered on the underside of the PC board.

S1, the blue LED switch, is also mounted under the PC board but soldered from the top side.

This completes the construction of the lower PC board so now let's move on to the upper PC board.

The upper PC board

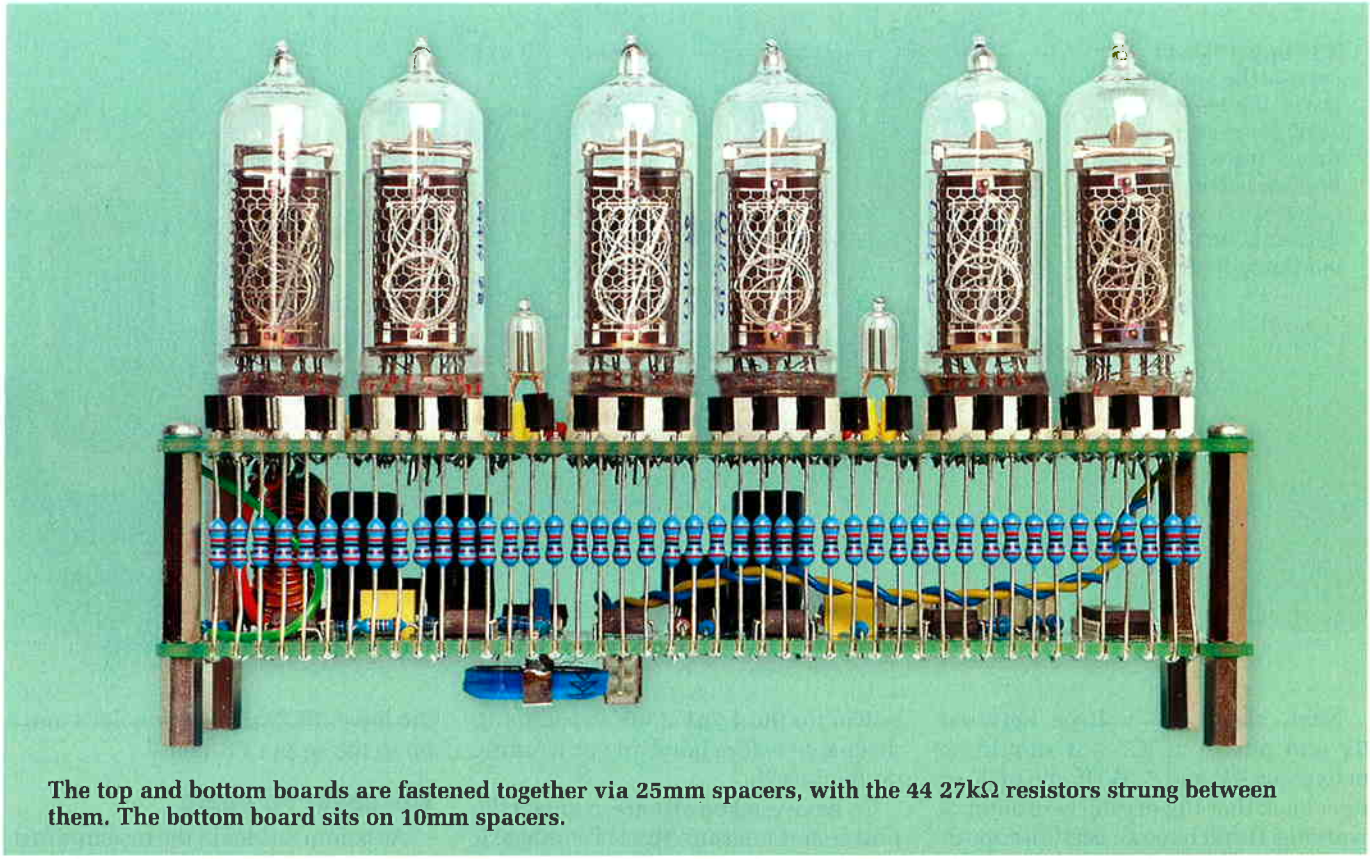
As before, solder in the resistors first. There are six 68kΩ 1W, two 330kΩ 1W and two 180Ω 0.25W resistors (if the blue LEDs are used). Incidentally, the 1W resistors are used not because we need their power rating but because of their higher voltage rating (the HT can exceed the voltage rating of lower-wattage types).

After the resistors, fit the 44 high voltage transistors, which may be 2N6517 or MPSA42 or MPSA44 types. All have the same pinouts and all mount with their flat side parallel with the righthand edge of the PC board.

To make a neat job of fitting the transistors use a piece of stiff, flat sheet material such as cardboard, larger than the PC board and temporary spacers made from two 3mm x 8mm screws and nuts (supplied in the kit). Fit

Where To Buy The Parts

(1) Complete NX-14 kit with finished metal baseplate (does ***not*** include housing or blue LED uplighting components): $179.00.
(2) Diecast aluminium housing: $39.00 in plain finish ready for polishing or painting; $45.00 supplied powder coated (shoji white).
(3) Transparent polished Perspex housing: $54.00.
(4) Blue LED uplighting kit: $19.00.
(5) 10V AC plugpack supply: $14.50
(6) Car lighter cable for 12V DC operation: $4.50
Spare 1N14 Nixie tubes: $15.00 ea.
The NX-14 Nixie Clock is also available fully built and tested. Enquiries to: Gless Audio, 7 Lyonsville Ave, Preston, Vic 3072. Phone (03) 9442 3991; 0403 055 374. Email: **glesstron@msn.com**
Note: the PC board patterns for this project are copyright to Gless Audio.



The top and bottom boards are fastened together via 25mm spacers, with the 44 27kΩ resistors strung between them. The bottom board sits on 10mm spacers.

the screws from under the PC board through the two mounting holes closest to the Nixie tubes and fasten with the nuts. Place all the transistors as far as they will go into the PC board in the direction shown on the component overlay and using the flat sheet to hold all the transistors into the PC board, flip the PC board and sheet over so that the board is upside-down, supported by all the transistors and the spacer screws. Carefully solder one outer lead on each transistor and then you'll be able to lift up the PC board without any transistors falling out.

Straighten any wonky transistors before finishing the soldering and cutting their excess pigtails. Then remove the temporary screws and nuts (the 3mm screws are used in the final assembly).

You can now fit the two neon tubes to their appropriate positions on the board (N1 and N2). Their height above the board is up to you but as they represent full stops around the bottom of the Nixie digits, they should be nounted about 8-10mm above the surface of the PC board.

Neons are not polarised but do operate from a high enough voltage to warrant short lengths of spaghetti insulation over the wires feeding down to the PC board. At short lengths, their wires are more than strong enough to have them stand up without any other support.

Fitting the Nixie tubes

A significant part of the visual appeal of the clock is the alignment of the Nixie tubes themselves. Having six Nixies at different heights and/or angles certainly would ruin the impact. First though, you have to get the Nixie wires into their respective holes. That might seem easy but in fact, it's quite difficult. The best method involves cutting the leads first.

First straighten the leads as best you can and then locate the anode lead. This has a grey/white coating on it, inside the glass envelope. Hold the tube with leads facing you. Leave the anode lead uncut and then going clockwise, cut each lead 3-4 mm shorter than the one before it until you have cut 12 leads. The result will be a spiral pattern of ever decreasing lead length.

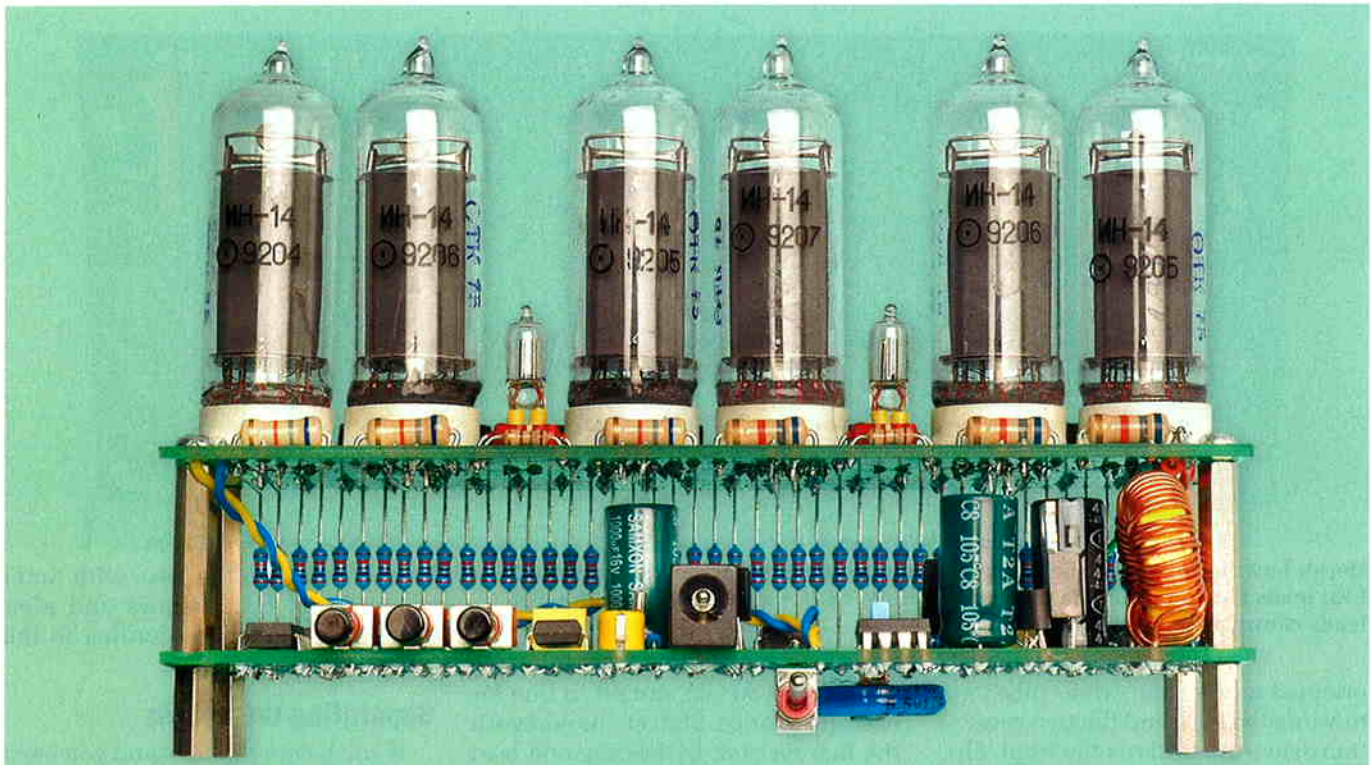
Now fit the tube to the PC board by inserting the anode lead (the longest) into the hole marked 1, which is closest to the resistors. You can then simply push the tube down a little until the next lead reaches the PC board surface and place that in the next hole. Continue working around until all the leads are in. This method also works nicely if the white plastic bases have come off any of the Nixies (you'll need to put the base back on before putting the Nixie on the PC board!).

When the tube is in place, hold it firmly down onto the PC board surface and as vertical and straight as possible before soldering the leads. Solder the anode lead and one directly opposite it first, check that the tube is still vertical and then solder another two at right angles to the first. Don't solder any more until all the tubes are inserted and soldered the same way.

Now check the tubes for alignment with the PC board and with each other. With only four leads of each Nixie tube soldered so far, it is easy to straighten the tubes by unsoldering the appropriate lead and then gently adjusting the tube position by hand. When all tubes are correctly lined up, your can solder the rest of the leads.

Fitting the blue LEDs

The blue LEDs are optional but they give the Nixie clock real character. The

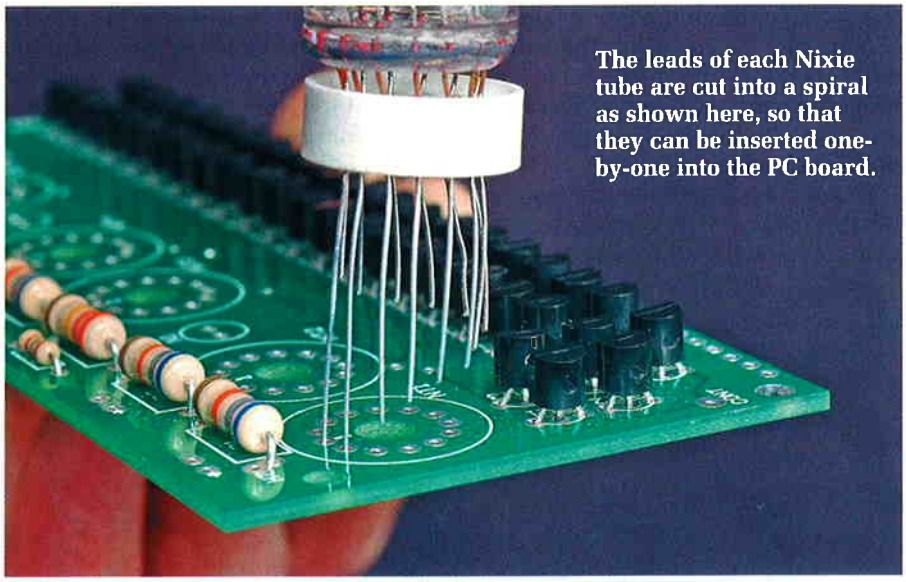


This rear view of the unit shows the three pushbutton time-setting switches, the DC power socket and the on/off switch for the optional LED uplighting.

LEDs poke up through the upper PC board from underneath, through the white Nixie bases (which have been drilled to suit) and rest against the bottom of the Nixie tubes themselves.

The LED leads are bent into a very broad "U" shape as shown in the photos and the leads are soldered to the copper side of the PC board. Because they clear the board by 2mm or so, we didn't bother insulating the leads, except those which go above inductor L1. Here we used some short lengths of plastic wire insulation.

The LEDs are a friction fit inside the white Nixie bases so no further support is required.



The leads of each Nixie tube are cut into a spiral as shown here, so that they can be inserted one-by-one into the PC board.

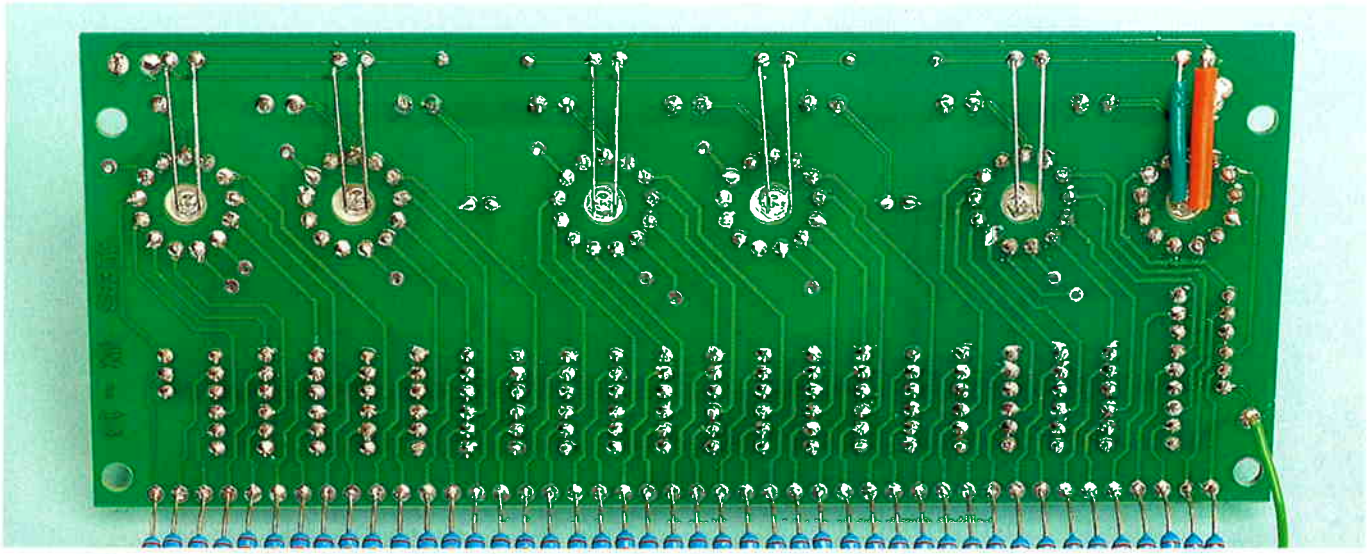
Inter-board connections

Apart from the 44 resistors connecting the two boards together, there are four PC board inter-connecting wires to be soldered into place. The LED power wires (two of them) connect to the bottom board next to the LED switch and to the top board at the back right corner (see the component overlay). These must be long enough to allow comfortable soldering while the two boards are still disassembled – say about 80mm long.

The other two wires, marked "CONT" and "HT" on the overlay, are shorter but must also be long enough to solder. The "CONT" wire can be around 35-40mm long, the "HT" wire about 70mm.

The two PC boards are fastened together using four 25mm hexagonal spacers which have male (external thread) and female (internal thread) ends. The female end goes towards the top PC board and is held in place by a 3mm round-head screw, while the male end passes through the bottom PC board, where an 8mm internal thread spacer screws onto it. The lower end of this 8mm spacer sits on the clock case bottom and is held in place by a 3mm countersunk-head screw from the outside of the case. Don't put the case bottom on just yet because you need to solder the resistors in place.

Make sure that the upper board is



Here's how the optional blue LEDs are fitted to provide the uplighting. Keep the LED leads clear of the Nixie tube solder joints and be sure to insulate the two leads shown with plastic sleeving – see text.

oriented so that the Nixie tubes are towards the back and the two rows of transistors are towards the front. Orientation of the lower PC board is more obvious – the switches and power socket are all toward the rear. This means that the resistor holes on the edge of the upper board line up with the row of slots on the lower board.

Now you get to solder the row of 44 27kΩ metal film resistors between the two boards. It is not as hard as it looks due to the slot and hole design on the PC boards.

If you are using the transparent Perspex case for the clock, take extra care and get the row of resistors as straight as you can and all in line for best appearance. Start at one end with the first resistor, by feeding one lead up into the end hole from under the upper PC board.

That done, centralise the resistor between the boards and solder it in place on the top board, from above. Drop the other resistor lead into the slot on the lower board then bend the lead down over the board and solder and cut it. Using the first resistor as a guide for position, continue to fit and solder all the other resistors in the same way.

That completes the electronic assembly of the clock. All that's left is to screw it to the base with 3mm countersunk head screws and after testing, fit the case according to the supplied instructions.

Separating the boards

If you have a problem and you need to check or change any of the components on either PC board simply remove the screws from the upper PC board and gently open out the boards until the components are accessible.

Time-setting

The three time-setting buttons at the rear of the lower PC board are: left (S4) stop, centre (S3) slow and right (S2) fast. If you overshoot by a little when setting the time, the Stop button can freeze the display until the moment it is correct. **SC**

This is the rear of the top board assembly. The two neons tubes are mounted 8-10mm above the board surface and are fitted with short lengths of spaghetti insulation to insulate their leads.

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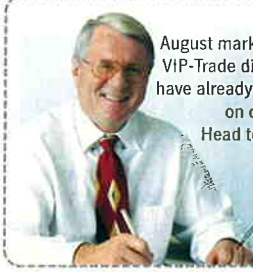

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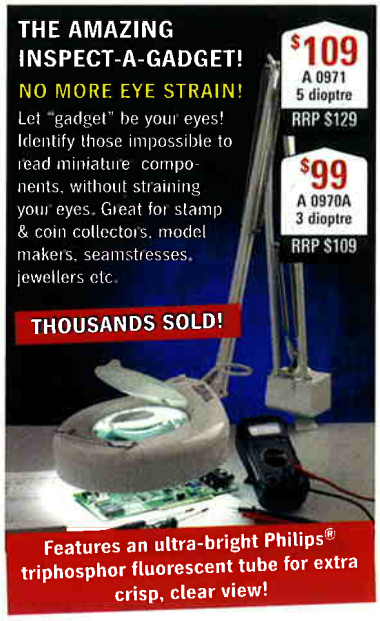

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"The SRC 3000 is a great product that can make life a little easier. A truly useful product you could use every day."
- Stephen Fenech, Daily Telegraph.

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NEW RELEASE!

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Designed to switch between 3 high definition sources. **Features:** • Up to 1080p resolution • IR extension for remote locating • Includes power supply & remote control • 120 x 65 x 23mm

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SAVE $70!

$129 S 5136 RRP $199

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This tiny camera can also see in the dark! Great for outdoor use, or even as an aquarium camera. **B&W only.**

$139 S 9080 RRP $189

Great performer, even outdoors or water prone areas.

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A new high tech solution for video monitoring anywhere in your house. Incredibly easy to set up, no messy wiring or difficult setup procedures! **Features** • 2.4GHz • AV output • Headphone output • Infra red lighting for night use • Supplied with 2 plugpacks.

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An essential for any electronics enthusiast!

Play A Game Of Robo-Ball!

INFRA RED REMOTE CONTROL SOCCER ROBOTS

Turn your table or floor into a soccer pitch with these fantastic fun robot kits. Supplied with all the parts to build one robot player and ball. The player can run after the ball, and features a powerful kick for spectacular long range goals! Play with up to 4 robots. For kids to build (ages 6 and up) and can be constructed in just an hour or two. Requires 6 x AA & 1 x 9V batteries.

$33ea K 1082 RRP $39

2 wheel design scoots along hard floors and tables at high speed!

Graphics LCD Module

NEW!

$35 Z 7052 NEW!

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(SC Nov 98) Simple & effective way to cool your turbo down & minimise damage after a long drive. Much cheaper than brand name timers & it can even be used with most immobilisers. **Features:** 90 second time out • Temperature sensor • Easy installation.

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(EA Jan '99) Perfect as a compliment to your regular alarm system. Mounts under the dash providing a 110dB screeching alarm inside the vehicle if thieves break in. Features an entry/exit delay, hidden switch activation & LED warning lamp. Kit form.

Create custom plastic parts in just minutes!

Great for creating model parts, moulds, brackets etc.

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Rigol DS506 digital

Rigol Technologies Inc, based in Beijing, China, manufactures a range of digital storage oscilloscopes, including the DS5062MA, a dual-channel DSO with a bandwidth of 60MHz and real time sampling rate up to 1Gsa/s. Other DSOs in the series have bandwidths up to 200MHz. The bandwidth can be reduced from 60MHz down to 20MHz to increase accuracy and reduce displayed noise, if required.

This particular model features a monochrome "¼ VGA" LCD screen (320x240 pixels) and has a memory depth of 4K samples per channel. The display refresh rate is over 1kHz.

The DS5062MA is supplied with two passive probes with switchable x10 attenuation, although it accepts probes with attenuations up to x1000. Inputs are rated at 400V maximum.

Running through the spec sheet reveals selectable input impedances of 50Ω (useful for RF measurements) and 1MΩ for almost everything else.

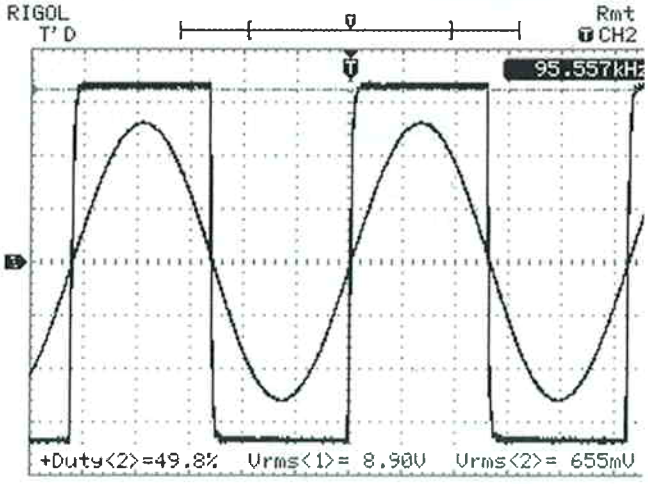

Fig.1: an AC-coupled sine wave and square wave at approximately 95.5kHz. The frequency counter is shown at top right. Three measurements are displayed on the bottom line: RMS voltage of both channels and the positive duty of the square wave.

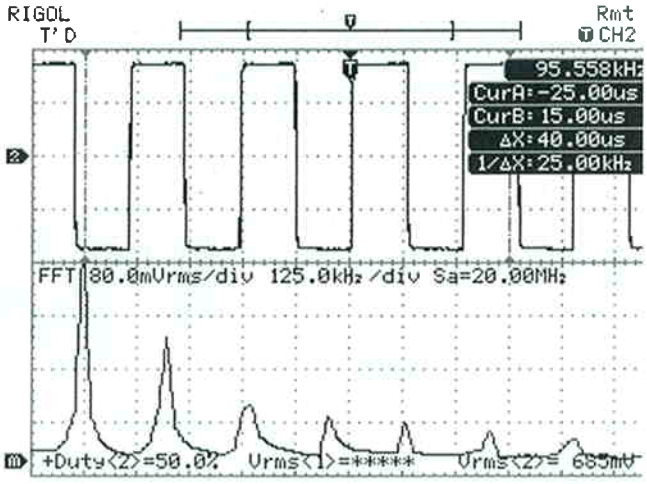

Fig.2: a square wave at approximately 95.5kHz, shown in the top half of the display and the Fourier Transform with peaks at the odd harmonics is shown below. In the top-right corner, you can see the frequency as well as the values of the two horizontal cursors, the difference between them and the frequency equivalent.

2MA 60MHz 1GS/s storage oscilloscope

Review by Mauro Grassi

It has 8-bit vertical resolution. There are 10 voltage and 10 time/frequency measurements, of which any three can be displayed at the bottom of the screen.

The voltage measurements include maximum, minimum, peak-to-peak, RMS, average and over-shoot and pre-shoot values (the latter as percentages). Time domain measurements include frequency, period, rise time, fall time and positive and negative duty periods.

You can also display all 20 measurements at the touch of a button but this reduces the active screen area for the traces. In addition, the signal frequency is displayed in the top righthand corner of the screen and you do not have to display a complete signal cycle for it to give a meaningful reading.

Two cursors are provided in three different modes of operation: automatic, manual (vertical or horizontal) and tracking.

The latter mode gives an X and Y cursor and the intersection of these can show the X and Y coordinates of any point on the waveform.

The DS5062MA can acquire average values (up to 256 values can be averaged) and detect peaks of the input waveform. The averaging feature, as well as the digital filter (providing low, high, band-pass and band-stop programmable filters) is particularly handy when working with noisy signals.

A nice feature is the so-called "analog acquisition", where the DSO calculates the probabilities of pixels being on or off and varies the intensity accordingly to mimic an analog display. When sampling at less than the Nyquist requirement an anti-aliasing feature is provided.

The DS5062MA has a surprisingly easy-to-use and intuitive pass/fail test feature. This allows for an error in the X and Y axes to be set and user rules to be defined. A mask is created, shown visually on the display in grey and when the test is commenced, any signal points that intersect with it trigger a user-programmable fail or pass response from the DSO.

The "MATH" feature allows the two channels to be combined in any of the four arithmetic relationships (add, subtract, multiply and divide) as well as giving an on-screen FFT (Fast Fourier Transform) with four modes: Rectangular, Hamming, Hanning and Blackman. The FFT can be displayed below the waveform in a split-screen arrangement or superimposed on the waveform in full-screen mode.

On-screen menus are accessed via five function keys to the right of the screen. These menus can be cleared from the screen by pressing the Off button or they can be set to slide off the screen after a delay (exit right!).

A convenient "AUTO" button configures the DSO to display the input waveform in a couple of seconds

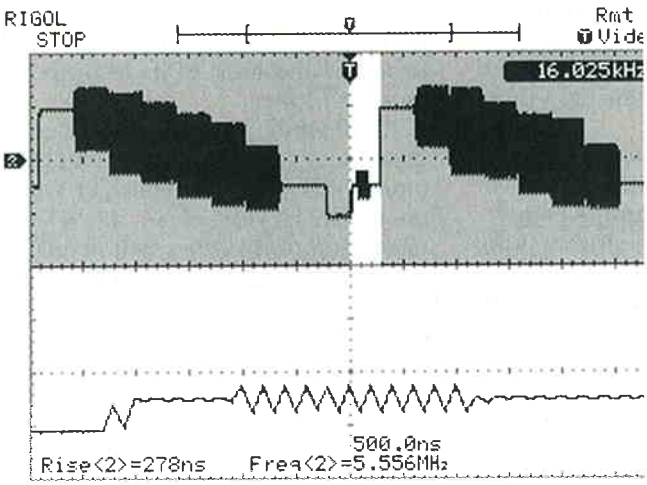

Fig.3: this is a PAL video test signal (eight colour bars) from the "Pocket AV Generator" featured in the June 2006 issue. The trigger mode is set to video and PAL is selected. The frequency counter shows 16.020kHz (actually 15.625kHz), the horizontal frequency. The sync pulse and the colour burst can be easily seen. The bottom half is an expanded display of the colour burst sequence.

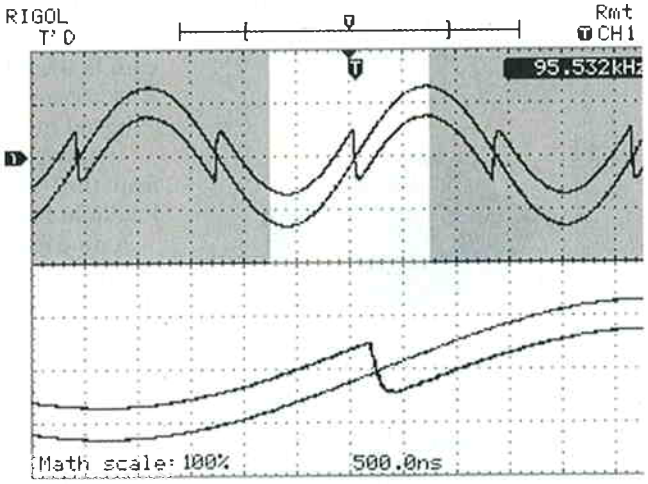

Fig.4:this screen grab shows channel 1 at top (a sine wave at around 95.5 kHz) superimposed with the maths function output of A-B where A is channel 1 and B is a square wave at the same frequency and phase. The lower trace shows the result of zooming in on the unshaded area in the top display.

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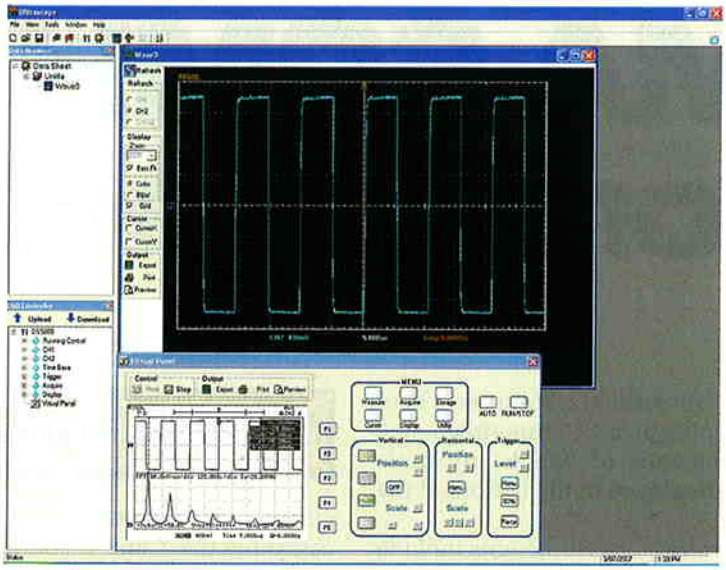

Fig.5: screenshot of the UltraScope software. The top window shows a captured square wave, while the bottom window is the "virtual panel". The side windows are used to control the DSO and store waveforms.

– much easier than fiddling with knobs to find the trace!

Another nice feature is the "50%" trigger button, which automatically sets the trigger level to the "centre" of the waveform.

Apart from selectable AC and DC coupling, the unit allows the trigger to be filtered. The LF reject option blocks low frequency triggering lower than 8kHz while the HF reject option attenuates frequencies above 150kHz.

Triggering can occur on edge, pulse and there is even a video mode compatible with PAL, NTSC and SECAM video signals (see Fig.3).

The DS5602MA can be connected to a Windows PC via a USB cable (not supplied) and is has optional GPIB and RS232 connections via the EM5-COM external module.

The scope can be controlled directly from the PC using UltraSco pe (downloadable from www.rigolina.com).

A nice feature of the software is the "virtual panel", a graphical interface that mirrors the oscilloscope, including its LCD screen. Waveforms can be captured locally on the DSO or downloaded to the PC.

A 320x240 bitmap file (.bmp) can be exported at the touch of a button.

Recording and playing back waveforms is easy. The unit can store up to 1000 frames, spaced at 1s to 1000s intervals. These can be downloaded to your PC for further analysis.

Up to 10 settings and 10 waveforms can be stored locally in non-volatile memory and there is a factory reset option.

All menus are persistent, meaning that they remember their last setting. The unit can be automatically calibrated and self-diagnostics check that the instrument is functioning correctly. In addition, there are key and screen tests to rule out obvious failures. It has multi-language support, the menu system is simple enough to be intuitive and the use of graphical cues is an added bonus.

So what is our overall reaction? The Rigol DS5602MA is a keenly priced, well-featured digital scope which is quite easy to use. It does not have multi-level menus which are hard to access and most of its features are quite intuitive.

All of which is great. The big compromise is in the display. While the mono LCD (black or white or white on black, is very clear, its ¼-VGA resolution (only 320 x 240 pixels) is a problem and will mean that fine details of complex waveforms will often be difficult to discern.

However, for less than $1000, you do get a lot of oscilloscope.

The DS5062MA comes with a three-year warranty, a user manual and a carry case. Recommend retail price is $799 plus GST. For more information on the DS5062MA and other DSOs in the series, contact the Australian distributor, EMONA Instruments on (02) 9519 3933 or email testinst@emona.com.au SC

PRODUCT SHOWCASE

Six-in-one portable test set from Ideal

The SecuriTEST portable instrument from IDEAL Industries is a complete six-in-one tool for the installation and maintenance of CCTV systems.

It is intended for field technicians, who will be able to complete an installation single handedly, it combines a video tester, video signal generator, PTZ (pan-tilt-zoom) protocol analyser and console, a UTP cable tester and a general-purpose digital multimeter in one hand-held unit.

The 2.5inch LCD colour screen can accept video from a CCTV camera thereby making it easy to see that the video signal is good. In the other direction, the video generator can provide a test signal to check a monitor or DVR. The SecuriTEST accepts both PAL and NTSC signals.

The PTZ controller can be connected to a compatible camera via RS485/422. Pan, tilt and zoom can be controlled at the press of a dedicated button. This is particularly handy for installations since the video signal from the camera can be watched on the unit simultaneously. The output from a PTZ console can be analysed for debugging purposes.

We tested the PTZ controller with a loop-back connection. The received data is shown in the screen in groups of hexadecimal bytes. The SecuriTEST can understand 19 common PTZ protocols, the camera can be made to move to preset positions and the speed of the movement can be controlled.

The UTP cable tester is an indispensable tool to check that wiring is good. It can quickly find open, shorted or crossed pairs on UTP cables. A terminating piece in the form of a keyring is provided to perform this function.

Finally, the digital multimeter allows the usual voltage, current and resistance measurements to be made. Currents up to 10A and voltages up to 400V can be measured. A continuity test that gives an audible beep when the circuit is closed frees the user from having to look at the screen.

Two BNC connections carrying video and two RS485/422 connections are at the top of the unit, while the UTP and power sockets are on the left hand side. The multimeter connections are standard.

The unit can be operated by rechargeable NiMH batteries that take around 8 hours to fully charge and will allow up to 4 hours of operation. The rechargeable batteries are supplied but can be replaced by 6AA alkaline batteries if required.

The keys are big and self-explanatory. Some keys have special functions when they are held pressed for a short period. For example, holding down the "Help/Hold" key gives context sensitive help.

The SecuriTEST is easy to use. As the LCD screen is meant as a test instrument only, its resolution and size is not overly critical.

The screen is bright and readable although there seems to be a lot of unused space. For example, the multimeter uses less than half the screen for its text. Presumably, this is to allow the video signal to be viewed simultaneously in the background, yet larger lettering with transparent rather than opaque background would have been better.

The multimeter keys are unused in the other modes. While this makes the interface uniform, it would be better to use these to switch to multimeter mode when the unit is in any other mode, rather than having to scroll through the modes one by one.

The SecuriTEST comes with a 1-year warranty and all necessary accessories to begin using it.

The SecuriTEST is not cheap but it will pay off in convenience. The price is $1395 plus GST.

For more information on the IDEAL SecuriTEST unit, visit www.idealindustries.com/pdf/Securitestss.pdf

Contact:
Trio Smartcal Pty Ltd
3 Byfield St, North Ryde NSW 2113
Tel: 1300 853 407 **Fax:** 1300 853 409
Website: www.triosmartcal.com.au

Altronics' new Universal Remote Control

Universal Remote Controls are great – but in most cases anyone over 10 has trouble programming them.

Altronics Distributors claim their new Sunwave SRC-3200 8-in-1 Touch Screen Infrared Remote Control is so simple to use even an adult can do it! It's one of a range of Sunwave remotes available from Altronics.

Instead of the six or more remote controls the average home now has, this unit takes care of everything (or up to eight of them). All you need do is tell it your device code and it knows what to do. Just in case your device code isn't listed, it can learn the codes you need. The extra large, backlit LCD screen makes switching between devices and then controlling them very easy indeed.

It operates from four "AAA" cells (not supplied). Cat no is A-0999 and it is now available from Altronics stores and most dealers for $269.00

Contact:
Altronics Distributors Pty Ltd
174 Roe St, Perth, WA 6000
Tel: 1300 797 007 **Fax:** 1300 789 777
Website: www.altronics.com.au

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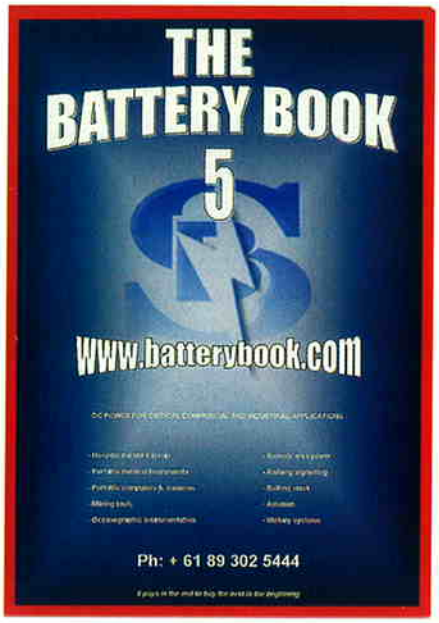

New from Siomar Battery Industries is this rather impressive catalog, which not only lists a huge range of batteries for critical and general applications but also giving their specs, including capacities, size, features and so on.

If you've ever wondered which was the right battery for your particular application, you're sure to find it listed in this 295-page tome.

The book covers all the major battery types and it would appear, most of the major manufacturers.

Chapters include:

- Primary batteries (alkaline, carbon, etc)
- Lithium primary batteries
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The Battery Book 5 is available direct from Siomar Battery Industries, either by phone or via the website below.

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Is there . . . or isn't there . . . a video camera?

Video surveillance cameras are everywhere these days and reports coming from many trouble spots suggest that the mere presence of video cameras is responsible for significant reductions in crime and anti-social behaviour.

Jaycar Electronics have available a range of video cameras to suit all applications – from cheap models for home security right through to infrared-lit professional models for night and day use.

But the video "camera" shown here is a bit different. It looks like a video camera, it has a flashing LED (battery powered, with a one-year life); and a fake "lens" to make it look like a video camera. It even has a "cable" emerging from the back into the mounting bracket to make it look like a video camera.

The only thing missing is . . . the video camera!

But who is to know that? You get the advantages of apparent video surveillance without all the trouble of wiring the camera into a recorder, etc.

And if you really wanted to, it appears to us that you *could* fit a small video camera into the case at a later date. (In fact, we are considering a future project where we do just that)!

The "camera" comes complete with the mounting bracket shown in our photo and even the screws and wall plugs to fit it.

The Dummy Surveillance Camera is available from all Jaycar Electronics stores and dealers for $34.95 including GST. Cat no is LA5316.

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3 Axis accelerometer with serial RS232 interface

From Ocean Controls comes the SerAccel v5, a 3-axis accelerometer up to ±6g with a simple serial interface. The latest SerAccel development, version 5 has many new improvements including variable baud rate, a factory reset command, and a complete triple axis measurement system based on the newly released MMA7260Q sensor from Freescale. Power is obtained from any RS232 port (including USB-to-RS232 converters) so no external power supply is needed. The onboard PIC (16LF88) runs at 10MHz and outputs three different types of outputs including calculated, binary, and raw outputs. The SerAccel v5 has software configurable settings to select between 4 sensing ranges (±1.5, 2, 4, and 6g), as well as a software selectable measurement frequency (0-590Hz).

The 3.2x4.4cm SerAccel outputs real-time accelerations from 9600 to 57600bps using visible ASCII characters. It is compatible with any RS232

Comm port in conjunction with any terminal program (Hyperterminal, VB Programs, or anything else that can read the comm port). A sample VB program is supplied.

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Tel: (03) 5983 1163
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Oatley's powerful 12V motors, controller

If you're looking for 12V DC motors with some real grunt for robotics, powered vehicles and craft, etc, have a look at these beauties from Oatley Electronics.

Left is a $14.00, 150W model which apparently was intended for an automotive application. We couldn't check the speed of this but it has some serious muscle. Size is approx. 85mm dia x 140mm (inc 8mm shaft).

On the right is a bargain kit containing an electric window-winder motor plus a 20A DC motor speed controller (ready to assemble). This motor is geared way, way down and so the output is very powerful indeed – don't even think of trying to stop it by hand!

Normally the kit retails for $36.00 but at the moment they are selling for $27.00 (while stocks last).

Oatley have a large range of motors for hobbyist and commercial applications – including a 500W, 36V model for less than $100.00

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Get ready for October Hong Kong Electronics Fair

The Hong Kong Electronics Fair (Autumn Edition) is the event of choice for the global electronics industry, serving as both a superb showcase for manufacturers and a powerful magnet for trade visitors.

In 2006, the fair attracted 2,481 exhibitors, over 3,700 booths from 29 countries and regions, including group pavilions from the Chinese mainland, Korea and Taiwan. A total of 57,791 buyers came from 151 countries and regions, including around 1,200 Buyers from Australia and New Zealand. This impressive performance helped to reaffirm its status as Asia's leading event of its kind and the second largest in the world.

In 2007, the 27th edition of the show will build on this excellent record to consolidate its position as the perfect platform for exhibitors to showcase their latest innovations and creations. With the hot favorites like Hall of Fame and Technology Exchange Zone the show is sure to be a hit again in 2007.

Major Exhibit Categories include:

- Audio Visual Products
- Digital World
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Running concurrently is electronicAsia, the region's leading event for sourcing electronic components, assemblies, production services and display technologies. In 2007, the show is set to feature around 540 exhibitors from 14 countries and regions and a total of 30,000 buyers are expected.

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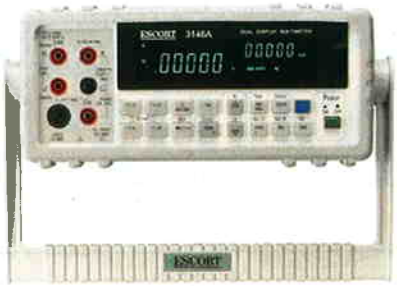

Escort bench-top multimeters

The Escort range of bench-top multimeters has been popular in Australia for many years. In recent times these multimeters have been hard to source but are now available again through Wavecom Instruments.

The range of bench-top multimeters now available from Wavecom includes the popular Escort-3146A model but also includes the 3145A and 3136A models. The cost of these bench-top multimeters is so attractive that they seriously challenge top-of-the-line handheld multimeters. Unless portability is a "must have" on your requirement list, these multimeters are worth considering.

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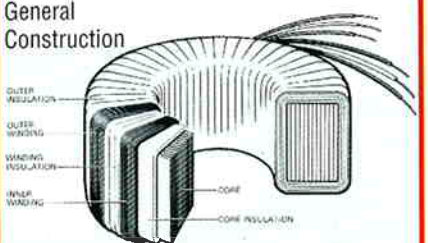

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Vintage Radio

By RODNEY CHAMPNESS, VK3UG

Restoring an AWA 948C car radio

First introduced back in the 1930s, car radios have been popular with motorists ever since. Here's a brief look at how they evolved, along with the restoration details for an AWA 948C dual-polarity car radio.

BACK IN THE 1930s, it wasn't too difficult to produce radios that ran from the mains supply and provided reasonable sound quality. By contrast, car radios provided quite a challenge for the radio design engineers.

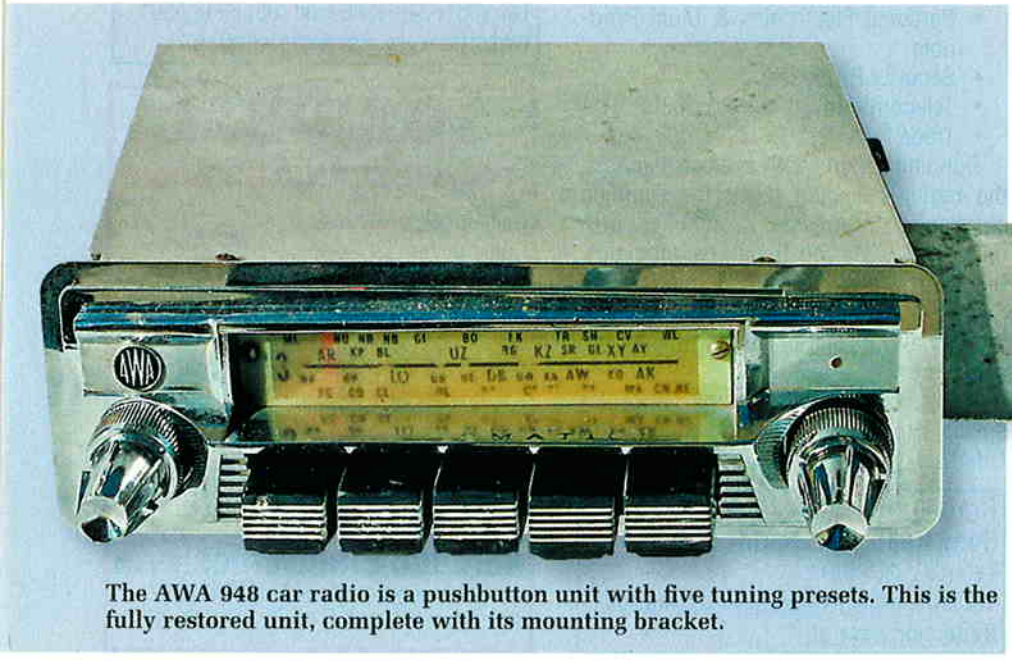
Initially, this challenge was met by using modified home-style receivers, complete with dry batteries and a wet-cell filament battery. These sets were mainly used when the vehicle was parked. However, the public wanted to hear music while on the move and that meant that specialised radios were needed.

There were quite a few problems to overcome to produce suitable radios, however. First, battery valves have relatively fragile filaments and bumping along the roads of the 1930s would have meant greatly reduced valve life. Second, the audio output of such valves was hardly enough to overcome the vehicle noise.

These problems gave birth to the 6.3V heater valves which suited the 6V car batteries widely used at that time. However, the high-tension (HT) supply was still a problem and some receivers had a small "genemotor" to supply a high-tension voltage of around 250V to mains-type valves. This device enabled audio valves such as the venerable 6V6GT to produce enough audio output to overcome the noise of a moving vehicle.

It wasn't long, however, before designers came up with the vibrator. This mechanical device converted 6V DC into 6V AC which could then be fed to a step-up transformer and rectified to provide the necessary 250V DC for the valve plates.

The first vibrators were half-wave devices and their design may well have been based on the concept used in the Ford Model-T ignition coil. The half-wave unit wasn't all that successful however, so after a short time the full-wave vibrator was developed. This subsequently became an integral part of car radio power supplies and survived right up until the early 1960s when hybrid and transistorised car radios took over from the vibrator-powered sets.

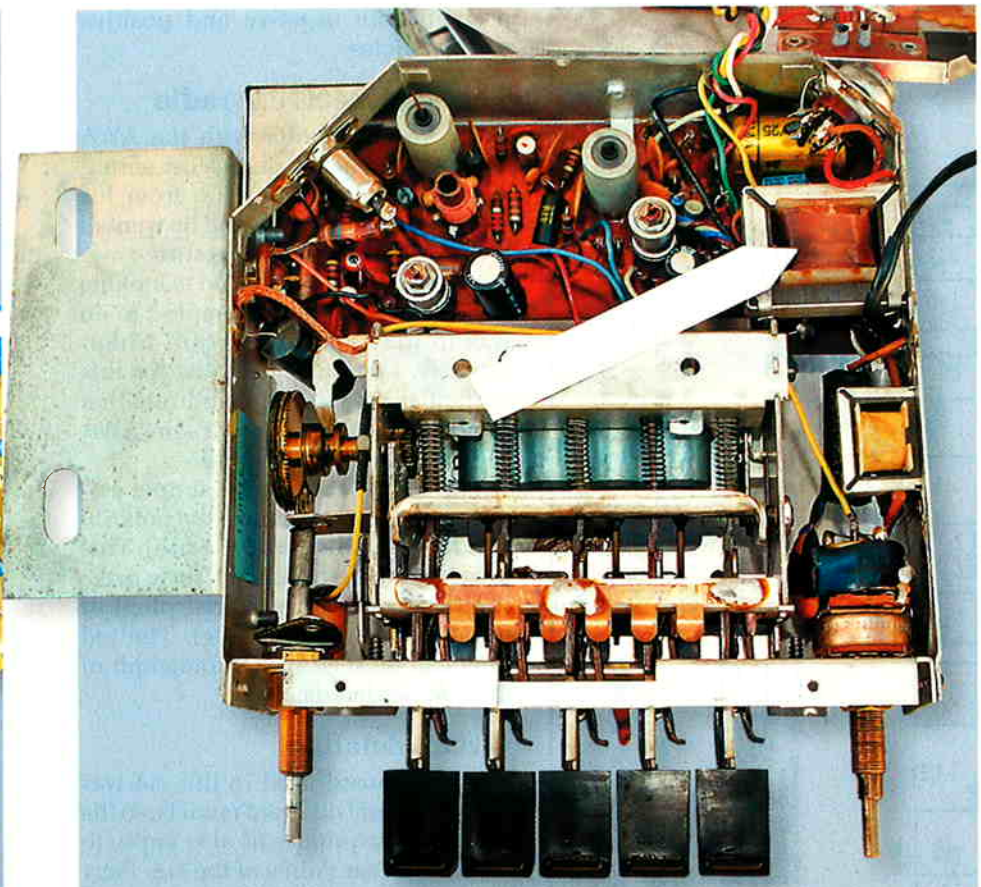


The AWA 948 car radio is a pushbutton unit with five tuning presets. This is the fully restored unit, complete with its mounting bracket.

Beating the interference

Yet another important development involved using a metal case to reduce interference from the vehicle's ignition system and other electrical gear. The battery supply to the receiver was also filtered to prevent any interference on that line affecting the receiver's performance.

The antenna lead was another important development, the designers coming up with a high-impedance coaxial cable. This shielded the central antenna lead from interference generated within the vehicle and was usually connected to an antenna mounted on a front mudguard. The antenna was (and still is today) a short whip-type mounted in a (relatively) interference-free area.



The audio output transformer arrowed prevents easy access to the audio amplifier components on the PC board. Note the size of the preset tuning mechanism which takes up about one third of the room inside the case.

Suppression of the ignition system usually took the form of a 400nF capacitor attached between the supply side of the ignition coil and earth. In addition, a 15kΩ resistor was included in series with the high-tension lead to the distributor. This resistor was specially designed for the job and its ends were simply screwed into each end of the severed high-tension lead.

Early vibrator sets

Early vibrator-powered car radio receivers were quite large. Sets such as the Astor "Square Box", for example, included a 200mm (8-inch) speaker inside the case, the set itself measuring 230mm square by 140mm deep. It was connected to the control head by Bowden cables.

Later sets were much smaller and used an external speaker that could be mounted in a location that favoured better sound reproduction.

In those days, car radios were produced as either "universal" units that could be fitted into almost any vehicle or they could be made specifically for particular vehicles. However, some of the latter were simply universal models supplied with different mounting kits and escutcheons.

I once received tuition on fitting car radios, back in the late 1950s in Adelaide. The time taken to completely fit a set (including its speaker and antenna) to an FE Holden and do the antenna tuning and ignition suppression was just 20 minutes!

Positive or negative earth?

The advent of hybrid and (later) fully transistorised receivers presented a new problem that had to be resolved. Most vehicles from the 1960s era had the negative terminal of the battery connected to earth (chassis) but there were also quite a few models that used a positive earth. This usually didn't matter with vibrator-powered car radios, as the valve rectifier fitted to most sets always gave the correct polarity for the high-tension line.

By contrast, both hybrid and transistor car radios had to be designed to accept either positive or negative earth

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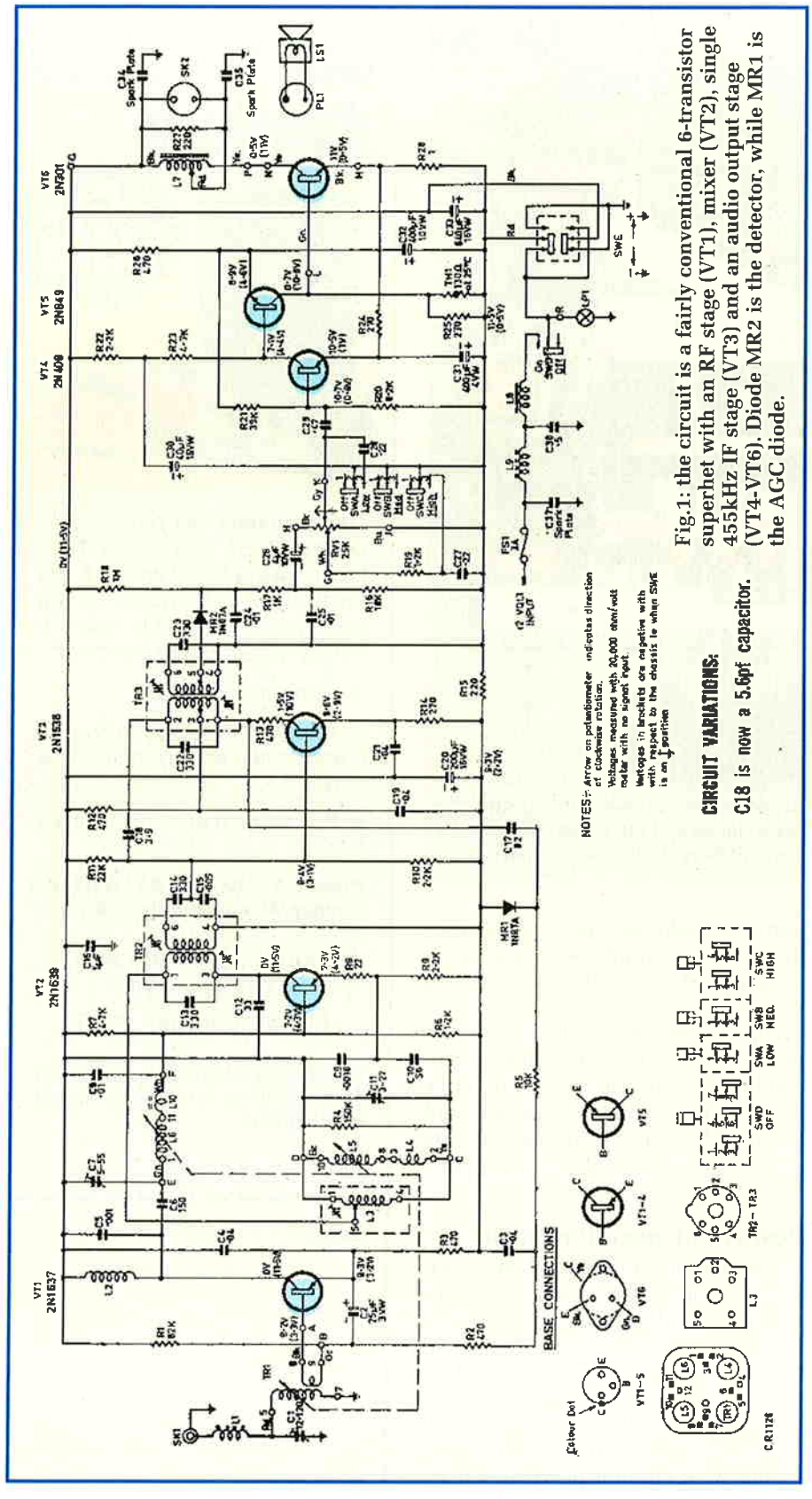

Fig.1: the circuit is a fairly conventional 6-transistor superhet with an RF stage (VT1), mixer (VT2), single 455kHz IF stage (VT3) and an audio output stage (VT4-VT6). Diode MR2 is the detector, while MR1 is the AGC diode.

(or both). You could not connect a set designed solely for a negative earth to a vehicle with a positive chassis earth or vice versa without doing considerable damage to the set.

The AWA hybrid set described in the December 2006 issue was designed for negative chassis operation. However, the AWA 948C unit described here is a fully transistorised set that can be used in both negative and positive earth vehicles.

The AWA 948C car radio

My first encounter with the AWA 948C came when a vintage car enthusiast handed me the radio from his Humber. It didn't work and he wanted me to overhaul it at my leisure.

When I finally got around to looking at it, the first thing I attempted to do was to track down a circuit. Unfortunately, I couldn't find one for this particular set but I did find one that appeared to be quite similar – the AWA MF3 series car radio circuit.

The AWA 948C used a simple colour-coded plug to change the polarity (the Humber was positive earth). This plugged into the back of the set to make it either positive earth (red plug) or negative earth (black plug). The red plug can be seen in a photograph of the overhauled receiver.

Circuit details

The PC board used in this set was used in several different models, so the circuit description will also apply to other AWA car radios of the era. Fig.1 shows the circuit details. As shown, it uses six transistors – three in the radio frequency (RF) sections and three in the audio section. The transistors are all PNP germanium types except for VT5, which is an NPN germanium.

Temperature compensation was necessary with germanium transistors as they are prone to thermal runaway if they get a bit too hot. As a result, thermistor TH1 and resistor R25 (lower right of the circuit) provide thermal compensation in the audio output stage, to prevent thermal runaway.

The antenna input is conventional for a transistorised car radio and is coupled to transistor VT1 via the aerial coil (TR1). Note that the cold end of the variable inductance tuned circuit is earthed directly to the chassis of the set, whereas the other sections of the set are only physically earthed at the polarity changeover socket and plug combination. The only other exceptions are the dial lamp and the capacitors in the interference-suppression filters in the supply line.

Following VT1, a second inductance-tuned circuit feeds VT2, the autodyne mixer stage. The signal is then fed to an intermediate frequency (IF) stage based on VT3 & TR3, which is tuned to 455kHz. Diode MR2 then

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detects the signal and this then drives the audio amplifier stage (VT4, VT5 & VT6). Potentiometer RV1 is the volume control.

The AGC (automatic gain control) voltage is developed by feeding part of the signal from VT3's collector to diode MR1. The resulting control voltage is then filtered and applied to the base of the RF stage transistor (VT1).

The audio stages (VT4-VT6) are direct coupled, which makes life more difficult for anyone servicing this section when something goes wrong (as it did in this set). The audio output stage is a 2N301, a common PNP germanium "power" transistor. It drives a 15-ohm speaker via a step down audio output auto-transformer.

Finally, note that there are three "spark plates" in this receiver – one on the power input and two on the leads to the speaker. These devices are designed to assist in filtering out any interference that may be on these particular lines.

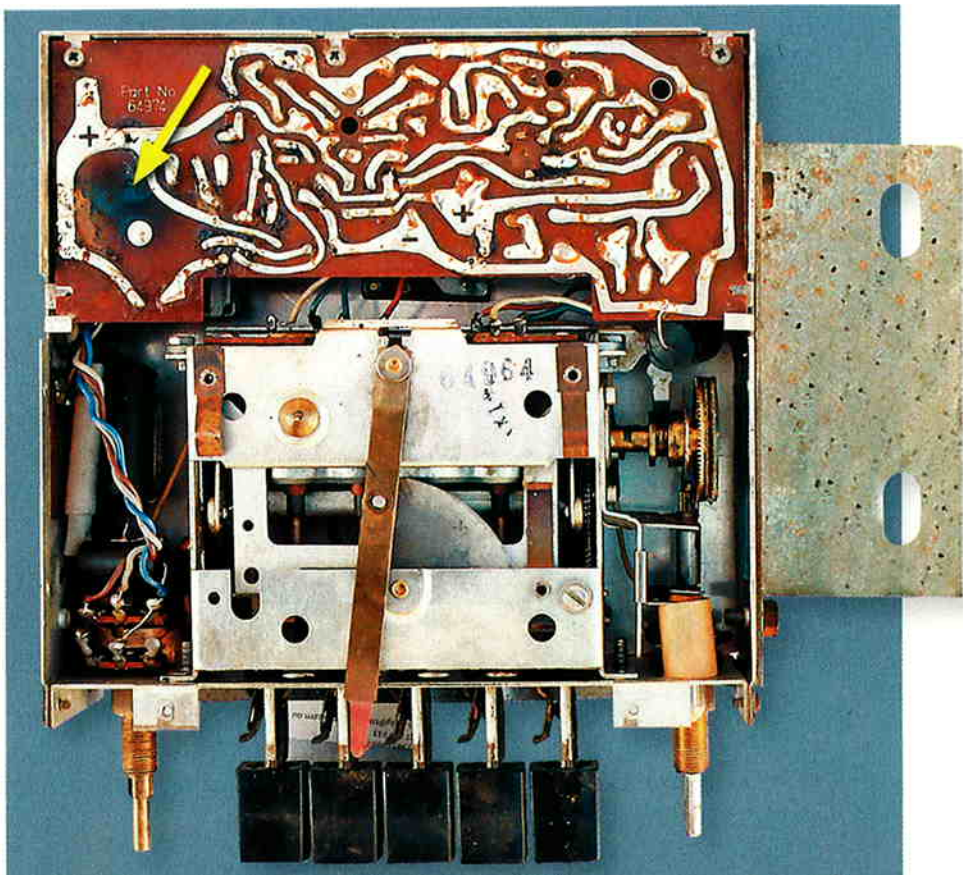
Overhauling the mechanism

Initially, I removed the top and bottom covers from the set and had a good look inside. This immediately revealed one obvious problem – wax had melted and leaked from the speaker auto transformer, indicating that it was getting too hot.

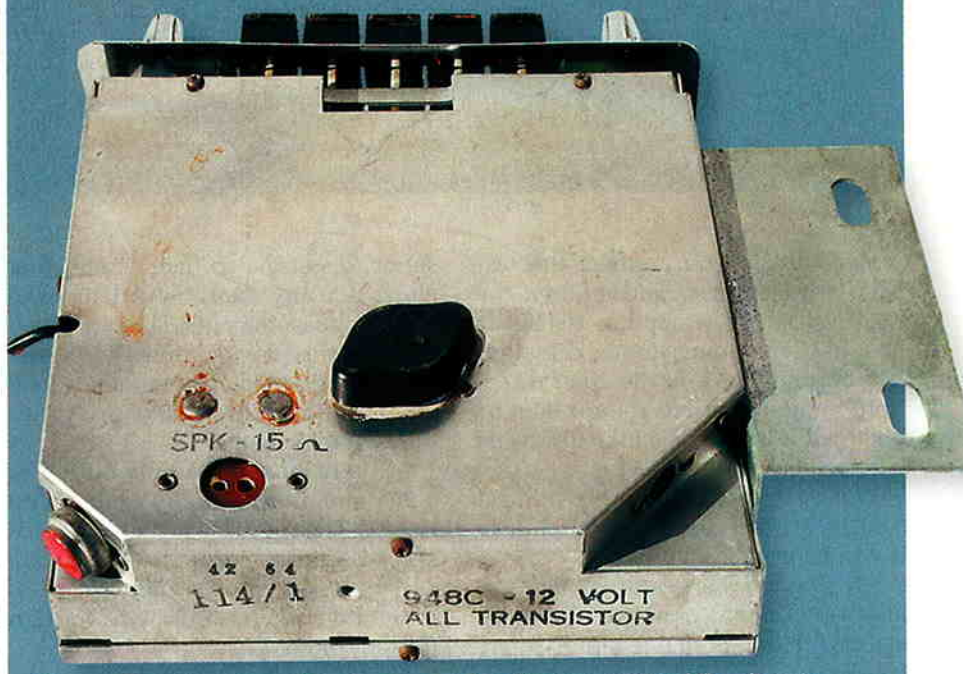
Further inspection revealed a problem with the dual-drive friction clutch and I decided to work on that first. The cork friction pad had come away from its metal drive disc and I reasoned that contact adhesive would do a good job of gluing it back into place.

Keeping the two sections of the clutch apart, I first smeared contact adhesive on to the side of the cork that would be in contact with the drive disc. That done, I made sure that the disc and the cork pad were lined up correctly before releasing the clutch. The clutch plate pressure was then sufficient to hold the two parts together while the adhesive dried.

Next, I lubricated the rest of the mechanism using my modified (blunt) hypodermic needle/syringe assembly. I then fitted a new terminal onto the active 12V line and installed a new 3A 3AG fuse. It was now time for some real troubleshooting.



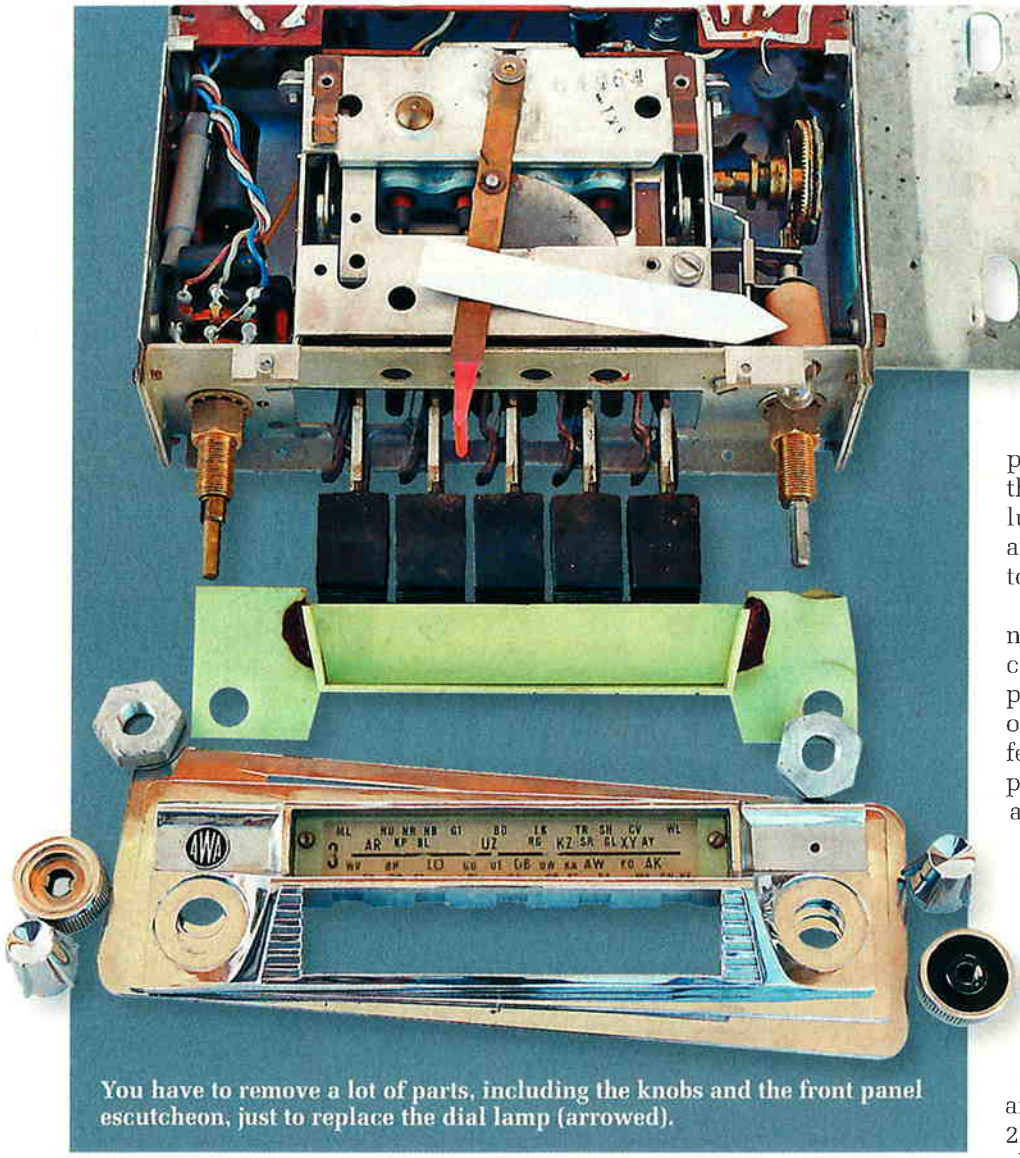
This is the underside view of the chassis with the cover removed. Note the charred area on the PC board (arrowed), around the audio output stage.



The audio output transistor is attached to the underside of the chassis (for heatsinking) and fitted with a plastic cover. Note the polarity plug at bottom left (positive earth in this case).

Overhauling the electronics

Because the speaker transformer had been overheated, I decided to remove the output transistor (2N301, VT6) from its socket This is done by simply undoing two screws and pulling the transistor out. I then tested it using the diode test facility on my digital multimeter (DMM).



You have to remove a lot of parts, including the knobs and the front panel escutcheon, just to replace the dial lamp (arrowed).

Basically, if you connect the test leads between base and emitter, the readings for a germanium transistor should be over-range in one direction and around 0.25V in the other direction. Similar readings should then be obtained if you connect the test leads between base and collector.

Well, I didn't get those readings! The 2N301 measured short circuit, so it was consigned to the bin.

My next job was to search for a suitable replacement, as germanium transistors are not all that common today (probably even less common than valves, in fact). Eventually, I did find one in my spare parts bin and it tested OK. This new transistor was then fitted into place after first smearing its mica insulating washer with heatsink compound.

I decided to leave the cover off the set at this stage, so that I could first check for any shorts and later take voltage measurements. The set proved to be clear of any obvious shorts, so I then connected it to my variable power supply with an ammeter in series with the negative lead.

Initially, I set the supply output to 1.25V and then gradually wound it up to 12V. The set drew just a few milliamps which indicated that there were still problems with the audio stages, as it should have been drawing around 0.5A or more.

Next, I checked the voltages on the 2N301 and they were haywire. I had suspected from the beginning that quite a bit of damage had been done in the audio section and I now thought that transistor VT5 (a 2N649) might be faulty too.

It was now time to really get serious about fixing the fault in the set. That meant being able to get at the audio section of the receiver but that's easier said than done.

First, I removed the screws that held the PC board in place. However, I was then able to move it only about a centimetre which gave me no more access to the audio section hidden beneath the audio output auto-transformer. Furthermore, I couldn't remove the transformer as this part was mounted with lugs through the side of the receiver case. These lugs are bent over flush with the case and soldered (it's obviously designed to be fitted once only).

Eventually, I decided to disconnect one of the short leads to the coil tuning assembly but I still had problems. The three leads from the output transformer and the two leads feeding the DC into the set from the polarity socket were much too short to allow the board to be moved. In fact, another 50mm of insulated wire on these five leads would have made all the difference.

In the end, I lengthened the two going to the polarity socket, leaving the others as they were. That done, I was then able to access the parts beneath the transformer.

I removed transistor VT5 (2N649) and tested it. It checked OK but the 2N301's 1Ω emitter resistor was a charred mess and the PC board had also been blackened due to heat – see photos. A nearby electrolytic capacitor had also suffered heat damage.

I replaced the 1Ω resistor and the two electrolytic capacitors, as I believed they might have been damaged. I then reconnected all leads and tested the set again, starting with a low supply voltage and slowly increasing it while monitoring the current.

As I increased the supply voltage, the voltage across the 1Ω resistor rose to around 0.6V. This indicated that the output stage was drawing around 0.6A, which is roughly what it should draw when working properly.

It was now time to connect an antenna. The set immediately burst into life, so I let it run for some considerable time and the 2N301 became only slightly warm. The sensitivity appeared satisfactory and the alignment of the antenna, RF and oscillator

coils appeared to be accurate. In fact, I rarely see car radio tuned circuits that are out of alignment.

Dial lamp

The dial lamp had blown and replacing it proved quite a chore. In fact, the entire front escutcheon had to be removed to gain access to it – see photograph. This is another example of poor design.

Furthermore, the original lamp was a 12V 150mA unit but I could only find one rated at 300mA. That problem was solved by installing a 10Ω 1W resistor in series with it to reduce the current drawn, which means that it should have a long life.

As a bonus, this also reduced the heating effect on the plastic dial sections, which appeared to have been overheated in the past.

Pushbutton tuning

Finally, it was time to take a look at the pushbutton tuning mechanism (I had been tuning the set manually up until this point).

For those unfamiliar with these units, it is necessary to tune manually to a station before setting the mechanism. This is done by pulling the press button out and then pressing it in hard. The mechanism is then set to select that particular station when its button is pressed.

This procedure is then repeated for the other four pushbutton.

The mechanism was still working correctly but the pushbuttons needed some restoration. First, I polished the tops of the pushbuttons with automotive cut and polish to improve their appearance. In addition, each button has five white recessed lines across it. These were looking rather shabby, so I "painted" the front of each button using typing correction fluid and allowed them to dry. Then, using fine wet and dry paper I carefully sanded away the correction fluid on the fronts of the knobs, leaving just the recessed lines.

The end result is not quite as good as I would have liked but the markings certainly look a lot better than they did.

Reverse polarity

So what caused all the damage to the output stage of this set? My suspicions are that it had been connected to a power supply with reversed polarity – probably not long before it was given to me to overhaul. This is a mistake that can easily occur with a dual-polarity set such as this.

The set is a good performer but the designer gets the thumbs down for the location of the speaker auto-transformer, as it obscures much of the audio amplifier. Additionally, the leads to it and other sections of the PC board are too short to allow access to the board without disconnecting several wires. Five of them could easily have been longer without any compromise in performance.

Access to the dial lamp is also poor and this could have easily been improved with just a little more thought. Still, it's a nice set to have in your vintage car. SC

Aeolian 5-Valve Autodyne Superhet (1933)

THE ORCHESTRAL COMPANY OF MELBOURNE was a well-known supplier of music and musical Instruments and the company also marketed radios under the "Aeolian" brand name during the early 1930s. The unit shown here is a 5-valve autodyne superhet from 1933. The valve line-up was as follows: 57 autodyne mixer, 58 IF amplifier, 57 anode bend detector, 59 audio output and 80 rectifier. Photo: Historical Radio Society of Australia, Inc.

These are the parts that were replaced. Note the corrosion on the transistor and the charring on the resistor and one of the electrolytic capacitors. The damage was probably caused by reversed supply polarity.

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Balanced electret mike wanted

I have seen and built many unbalanced electret mike preamps but would now like to build a phantom-powered balanced electret mike. To date I have not been able to find any circuits in previous issues.

Ideally, the circuit would be able to mount inside an XLR or 6.5mm jack plug. It may also be possible to create a circuit that would enable an external battery if phantom power is not available but still remain balanced. (D. P., via email).

● Have a look at the Lapel Microphone Adaptor project in our January 2004 issue and the add-on phantom power circuit in the February 2004 issue (Circuit Notebook).

How to dispose of used etchant

A few months ago, in a flash of optimism and enthusiasm, I bought a beginner's Riston PC board kit, with a little tank, PC boards, sachets of developer and etchant - from a major electronics component retailer. I made my transparency, as needed and then found that I had a problem.

Being environmentally and OH&S conscious, I began looking for suitable plastic bottles to put the (as yet unmade) solutions into. Not wanting to use old milk or juice containers or pasta sauce glass bottles, I found that something that should be relatively simple to find wasn't.

In addition, with no MSDS (Material Safety Data Sheets), I am unsure whether I will have to store the solutions indefinitely or if there is some way to suitably deal with the wastes. Nowadays, you can barely walk without tripping over talk of environmental or personal safety, yet I found this an area to be curiously lacking such advice. (C. G., via email).

● We have never been able to get a definitive answer on this question. For hobbyist use (ie, small volumes) the only practical method is to massively dilute the etchant and then flush it down the sewer. Alternatively, if your council has a regular pickup of paints, pesticides etc, use that.

Non-corrosive silicone sealant

Can you advise of a non-corrosive silicone that can be used with PC boards? I need to stabilise some electronic components in an area subject to fairly severe vibration. (M. T., Hobart, Tas).

● Any of the roof and gutter sealants should be suitable. These are neutral-curing as stated on the labelling; eg, Selleys Roof and Gutter Silicone or Parfix Roof, Gutter and Concrete Silicone.

Cordless Tool Charging Controller

I've just put together the Cordless Drill Charging Controller (SILICON CHIP, December 2006) and it seems to be working. However, I'm puzzled about some of your assumptions about the average drill charger and some of the specifications of your design.

Inside the original charging cradle, the circuit was very similar to the one in your article about bringing a dead drill back to life. However, the plugpack for the charging cradle is an 18V 400mA DC supply.

When I measured the actual charging current drawn by the cradle from the plugpack, it is approximately 300mA.

Power supply design and earthing

After browsing through a number of SILICON CHIP articles on amplifiers, mains-operated circuits and the like, I have a few questions.

Most of the articles use 6.4mm spade lugs for earthing. Could a 3.2mm ring terminal not be used or is there a specific reason for avoiding ring terminals; ie, low current capability, weaker structure, etc?

When rectifying AC to DC in the power supply modules, the approximate output voltage with a bridge rectifier and smoothing capacitors is ACV x 1.414 = DCV.

I've noticed that many of the SILICON CHIP circuits don't seem take into account the 0.9-1.4V drop from the diodes. Is this because it is only meant to be a rough approximation?

If so, would it be damaging to a circuit if the stated voltage in the article was used.

For example, if the article power supply has rails of ±25V but the real life voltage was ±23.47, would it be damaging to use an actual ±25V.

I realise this 1.53V difference would be negligible but for a higher-powered circuit, the voltage difference would be in the order of 4-5V.

● You can use alternative connectors to spade lugs. 3.2mm eyelets are also OK.

Power supply voltages are always approximate, because the transformer output does vary with load.

Normally, the diode drop does not contribute to much voltage loss and the drop varies with load in any case. This drop is small compared to the transformer output voltage variation with load; ie, its load regulation.

The transformer secondary voltage can also be 10% higher or lower depending on mains voltage (line regulation).

Amplifier supply voltages are also given as approximate values and may vary significantly due to the transformer regulation reasons. So a ±25V supply versus ±23.47V is not a problem.

The batteries in my drill (totalling 14.4V) are 1.2Ah Nicads (according to the manual) and charging time is stated as 3-5 hours. Where I am confused is that on page 34 of your article, you say that the "top up feature provides a reduced charge (typically at 400mA) for an hour."

Noting that you use the word "typically", I am puzzled as to why my charger is so different – my standard unintelligent (ie, dumb) charger supplied with the drill only supplies a maximum of 400mA and in reality it charges at about 300mA which means my standard charge current is less than your typical reduced charge current.

So when you talk about a "reduced charge" in your article what sort of current are you suggesting is typical of a non-reduced charge?

On page 38, you give an example and I'm not sure if it is supposed to be hypothetical or typical. You say that "if the main charge current is 3A..." – my charger clearly isn't even close to that. So I guess my question is – could I substitute a different plugpack to provide a higher charge current to my charger when using the charger controller kit?

I was also puzzled with regard to the use of the "top-up and trickle charging option". This seems to make a lot of sense to me because I can just leave the batteries permanently on charge. However, it made me wonder if it was going to fully charge my batteries well in the short term or should I bring link 2 out to the side of the case so that I can charge normally when I have a flat battery or use the top up and trickle charge when I'm working with a battery that isn't completely flat?

You don't specify what charging rate is used for normal charging so I measured it and it is 260mA when used with my plugpack and cradle but I measured the top-up charge to be exactly the same – is this correct? Does the circuit always deliver a charge lower than the original charger did on its own?

Or is it confused by the fact that the kit seems to remember what mode it was in before you disconnect the power? Is it remembering that I pressed the start button while it was in top-up mode and therefore when I disconnect the power and change the link and then reconnect the power, it continues in the mode it was in previously when I pressed the start button?

I know that you've had some comments in recent editions about the use of programmed chips versus discrete components and I guess my question above highlights the deficiency of using programmed chips.

Short lamp life in multiple lamp fittings

I have several 3-lamp ceiling lights as well as a 2-lamp unit (all incandescent). When I put a set of lamps in the 3-light units, one will blow after about a week, another will blow after about a month and the last will go on until the end of its normal life.

With the 2-lamp unit, one lamp will blow after about a week and the remaining one will last the normal time. This has been the situation for several years and I have given up replacing lamps until the last one blows.

I wouldn't have thought that the filament in a normal incandescent lamp would have had enough inductance to create a spike of sufficient power to blow another similar lamp at switch-off, especially as it is in parallel with another (unless, of course, two of them are 'ganging up' on the remaining one).

In any case, I had thought of putting a mains-rated capacitor across the common power input (or even across each lamp) as a snubber device but I don't know how much good this would do. On one of the 3-lamp units, I even replaced the incandescent lamps with low-energy fluoros but one of these even blew after a month. Any ideas? (A. F., via email).

● This sounds to us like a clear case of "lamp domination syndrome" whereby one lamp kills the others so it can luxuriate in isolated splendour, sucking in as much current as it wants. Cuckoos do much the same thing, pushing the other chicks out of the nest so that they get all the food.

Seriously, we think the CFL failure in the same fitting is the clue. The likelihood is that the lamp fitting is an oyster type or something similar which causes the lamps to seriously overheat. That is why, when the fitting only has one lamp operating, it lasts for its normal life.

The only solution may be to fit lamps of minimum power rating, say 40W or even 25W, to reduce the maximum dissipation in the fitting. In fact, you may find that the fitting has a label inside, stating the maximum lamp rating.

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely.

Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

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Had you used discrete components (which would have made this a lot more complex and expensive and probably impractical for most people – cheaper to buy a new drill every three months maybe), you would have fully explained how your circuit worked but because you programmed a chip, you didn't go into as much detail.

So my suggestion is go ahead and program chips but when you do, please explain more about what the chip is doing. In this case for instance, tell us that the chip is remembering the state it was in before a power failure, tell us how often the chip checks the links – is it just when it doesn't have an existing state to return to (ie, the first time it is used) or is it every time it is powered up?

Tell us how we can reset the state of the chip and make it forget the state it was in before – like the master reset on a computer where you can reboot the chip and it will return to the state the manufacturer originally supplied it in rather than the state it was in when you "hibernated" it.

Or maybe I'm giving too much credit to what you included in your software for this circuit. Anyway, please keep up the great articles and projects. (S. W., via email).

● Because there are so many power tools, we only mentioned typical charge values. The charger gives a wide range of adjustment to allow for low rate chargers such as the one you have.

The top-up charge is 4x the trickle charge. So if you have set the trickle to 1/4 or more of the full charge, then the top-up will be the same as full charge.

The processor looks at the link connections when it is necessary. That is at the start of charge for the timeout multiplier LK1, at the end of charge for the top-up and trickle link LK2 and the x5 LK3.

Once the process has started, then the links can be changed without effect until the charger is restarted with S1. The current status is remembered during power down, so that the charger can continue on if a power outage occurred during charging. Pressing the start switch will enable the new link settings to be re-read by IC1.

It does not matter if you select top-up and trickle when charging a not-so-flat battery. The top-up is still valuable in getting the most from the batteries.

According to our calculations, for a 1.2Ah battery pack and full charge current of 300mA, you should select the trickle at 1/5, ie, 1.2A/20 = 60mA. 300mA/60mA = 0.2. LK3 needs to be out and VR3 set at 0.5V.

The top up will be approximately 240mA or 4/5 of 300mA.

GPS-based Frequency Reference

With respect to the 10MHz GPS-based Frequency Reference (SILICON CHIP, March, April, May 2007), is there some advantage I am not seeing in your design using the one-second pulses, as it looks quite complex?

I built a version recently using a simple PLL and a 10MHz oven oscillator divided down to 10kHz for phase comparison with a standard Jupiter 12-channel GPS which also has a 10kHz output. This has been extremely stable and has been working very well, making the whole project easy and simple to build. The one problem I have is that I cannot think of a way to measure its actual precision and stability! Do you have any answers? (T. P., Ashmore, Qld).

● The only reason we've used one-second pulses in the GPS-based Frequency Reference is that the Garmin GPS receiver module doesn't have a 10kHz output. Using the 1pps output was therefore our only real option and it didn't really add a great deal to the complexity.

We agree that it isn't easy to measure its actual precision and stability directly, if one doesn't have a Caesium-beam 'atomic clock' to use as a reference! It is only possible to gauge its performance indirectly, by monitoring its PLL error voltage.

Volume limiter for a TV set

I operate a motel with eight rooms, each with a Samsung TV set. I have problems with guests who turn up the volume too loud, causing problems with other guests. Do you have a kit that I can place between the audio output and the speakers so that I can attenuate the volume so it would not go up past a preset level? (J. M., Mallacoota, Vic).

● No kit is necessary. All you need is a resistor connected in series with the signal to the volume control potentiometer, assuming that the sets do have a conventional volume control knob. The value of the resistor depends on the resistance of the volume control and how much you want to curtail the loudness from the TV set. To give an example, if the volume pot is 20kΩ, we suggest you try connecting a 56kΩ or 68kΩ resistor in series with the signal to potentiometer. If that does not give a sufficient reduction, try doubling the value, to 100kΩ or more.

Alternatively, for a cruder approach, just connect a 47Ω (or higher) 5W resistor in series with the loudspeaker.

Fuel cut defeater has drawback

The Fuel Cut Defeater (SILICON CHIP, February 2007) is a wonderfully simple way of bypassing boost limiters in some engines. However the way it's configured means it should only be used on vehicles with a separate MAP sensor just for the boost limit function.

Some cars such as early turbocharged Toyotas use the same MAP sensor to monitor both air flow and boost. On these engines, having the Defeater drop the output signal from 3.9V to 1.4V as the engine approaches maximum load and revs would result in the ECU interpreting a large reduction in airflow. As a consequence, the ECU would lean out the injectors and advance the timing under hard load, with the likely result being a blown head gasket at best and engine destruction at worst.

A better arrangement would be to modify the circuit to have the output clamped at an adjustable voltage point which could be set on the vehicle to a voltage just below that which triggers the boost-cut function. Even here though, it may not be advisable to take the boost too much higher than standard, as the ECU will still be providing the timing and fuel figures for what it thinks is a lower air flow into the engine. (H. C., via email).

● As advised in the article, it is always advisable to monitor turbo boost when using the Fuel Cut Defeater. Having an adjustable clamp level would solve the lean-out and timing changes problems that you mention. To provide an adjustable clamped voltage you would need to place a trimpot wired as a variable resistor (wiper to one side terminal) between pin 7 of IC1b and the cathode (k) of diode D3.

A 10kΩ trimpot should be suitable and it can be adjusted so the output provides the required level to the ECU dur-

ing overboost. The variable resistor will act as a soft clamp for the MAP sensor signal introducing attenuation of the signal level at the IC1b threshold. This will still allow a rising signal with input level from the MAP sensor via IC1a's output and 1kΩ resistor, so that ultimate fuel cut out will still occur.

Technics turntable vacillates

I have a weird problem with a Technics SL1600 MkII turntable. When you place a record on it and start it, instead of rotating clockwise as usual, it goes back and forth about a quarter turn for a while before turning itself off.

I don't think it is the main bearing sticking, as I have previously put a couple of drops of sewing machine oil on it and it spins freely with light finger pressure. This model uses infrared sensing for disk size and I wonder if it may be something to do with this.

The service agent I took it to were not able to repair it, as they could not get service manuals from Panasonic any more and they considered that it was probably too old to be worthwhile.

Combined with an AKG P8 ES Van den Hul II cartridge it had a beautiful sound and gave me many years of service.

Has anybody out there seen this problem? I would appreciate any advice as I've not been able to find anything like it on the internet. (R. S., Newcastle, NSW).

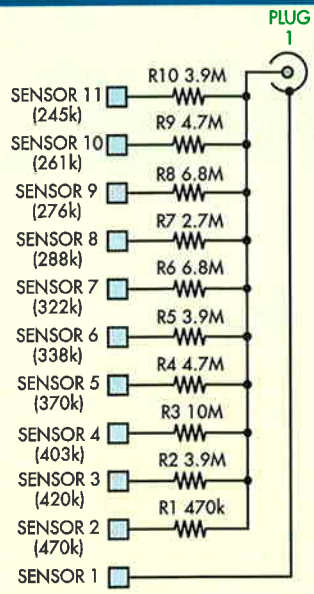
● The Technics SL1600 was a very fine turntable and it would certainly be worthwhile to have it fixed. Technics used direct drive and they referred to it as having a brushless DC motor but it was really a 3-phase AC induction motor with tachometric feedback.

There evidently is some problem with the drive circuitry but we are not familiar with it and so we are not able to give you a specific pointer.

Perhaps one of our readers has a manual or has experience with this problem. SC

Notes & Errata

Tank Water Level Indicator, July 2007: unfortunately, testing in an actual tank has shown that the 10 resistor values shown in the sensor string on page 34 are seriously in error. The corrected values are shown in this diagram which shows the relevant portion of last month's circuit. The resistor values are shown for R1 to R10, together with effective sensor resistance which is brought into play as each sensor is successively covered by water.



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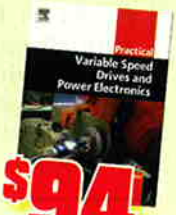

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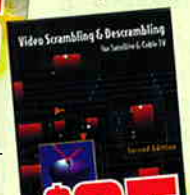

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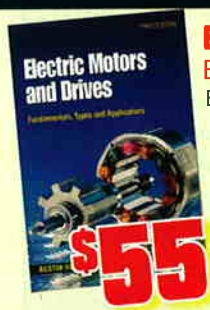

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